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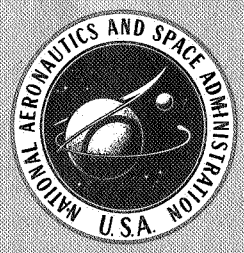

COMMUNICATIONS SATELLITES

A CONTINUING BIBLIOGRAPHY

WITH INDEXES

MAY 1967

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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NASA SP-7004 (03)

COMMUNICATIONS SATELLITES

A CONTINUING BIBLIOGRAPHY
WITH INDEXES

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA Information System during the period February, 1966–March, 1967.

Scientific and Technical Information Division
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. MAY 1967

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Introduction

With the publication of this third supplement, NASA SP-7004 (03), to the original issue of Continuing Bibliography on "Communications Satellites", the National Aeronautics and Space Administration continues its program of distributing selected references to reports and articles on aerospace topics that are currently under intensive study. The references are assembled in this form to provide a convenient source of information for use by scientists and engineers who need this kind of specialized compilation. Continuing Bibliographies are updated periodically by supplements which can be appended to the original issue. All references included in SP-7004 (03) have been announced in either *Scientific and Technical Aerospace Reports (STAR)* or *International Aerospace Abstracts (IAA)* and were introduced into the NASA information system during the period February, 1966–March, 1967.

The transmission of information by means of communications satellites is a new technique that promises to be a powerful stimulus for effective international cooperation in the investigation of space. In their flexibility of design, communications satellites also offer a multitude of opportunities for commercial and industrial development. The contents of this bibliography exemplify this diversity by including references to such topics as television broadcasting, telemetry, outer-space systems, multi-station systems, and medium-height, random-orbit systems. The economic and legal implications of communications satellite systems are represented. References are also included which describe the history and operation of individual satellites such as Advent, Courier, Echo, Relay, Score, Syncom, and Telstar, as well as several satellites used for meteorological studies.

Each entry in the bibliography consists of a citation and an abstract. The listing of entries is arranged in two major groups. Report literature references are contained in the first group and are arranged according to their date of announcement in *STAR*. The second group includes journal and book references, arranged according to their date of announcement in *IAA*.

A subject index and a personal author index are included. These indexes use the Notation of Content (NOC), a one-sentence description of the contents of a document, rather than the title, to aid the user in locating pertinent entries.

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For further details please consult the *Introductions* to *STAR* and *IAA*, respectively.

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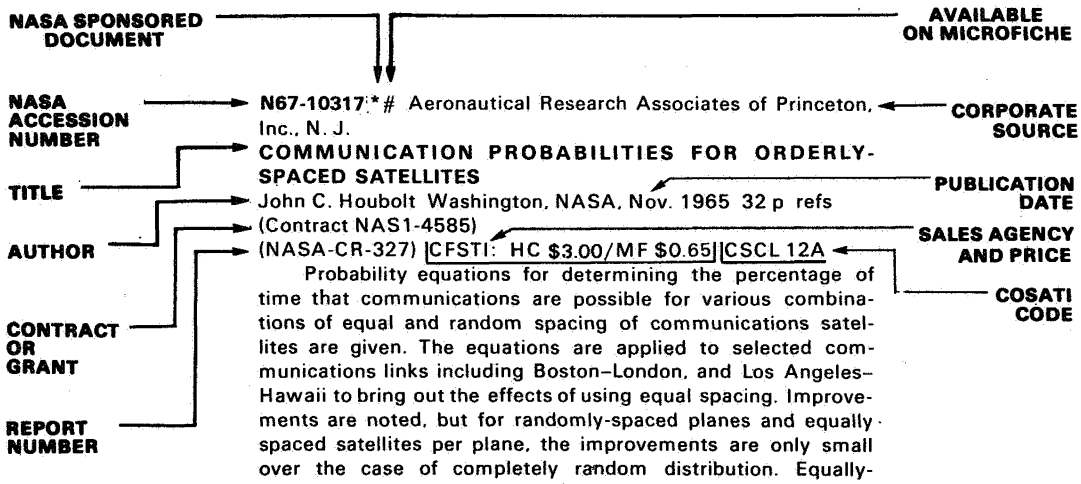
TYPICAL CITATION AND ABSTRACT FROM *STAR*



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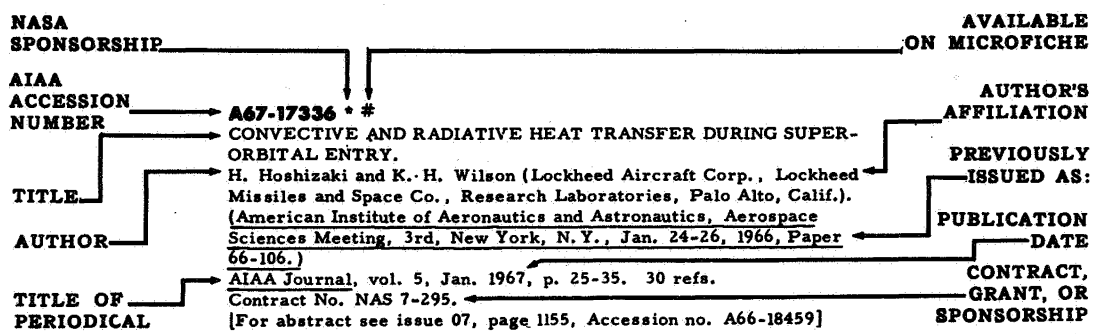

COMMUNICATIONS SATELLITES

a continuing bibliography with indexes MAY 1967

1966
STAR ENTRIES

N66-18458*# National Aeronautics and Space Administration, Washington, D. C.
SIGNIFICANT ACHIEVEMENTS IN SPACE COMMUNICATIONS AND NAVIGATION, 1958–1964
1966 73 p refs
(NASA-SP-93) GPO: HC $0.45; CFSTI: MF $0.75 CSCL 17B

The early history of satellite communications development is reviewed, and the highlights of communications achievements are noted. Details are given on the launchings and operational capabilities of the passive and active communications satellites, and their performance in transcontinental and intercontinental experiments is assessed. Technological progress is summarized, and the formation of the Communications Satellite Corporation for exploitation of the commercial possibilities in a global system is discussed. A bibliography is included. M.G.J.

N66-19139*# Conductron Corp., Ann Arbor, Mich.
RADOME FACILITY Final Report
[1965] 133 p refs *Its* Rept.-0038-RF-1
(Contract NAS5-3232)
(NASA-CR-70821) CFSTI: HC $4.00/MF $1.00 CSCL 14B

The construction, installation, and checkout of a radome measurement facility are reported. The purpose of the radome is to provide a capability for measuring the microwave reflection and transmission characteristics of passive communications satellite materials. A theoretical and experimental evaluation was made of the electrical properties of the radome and their effects on measurements. Included in the evaluation were a determination of reflection coefficients for various materials, and an investigation of high frequency scattering from a conducting sphere surrounded by a thin wall radome. The possibility of using the radome as housing for a transmitting antenna is discussed; and the test fixtures are described along with the instrumentation systems. Extensive support facility and test fixture drawings are also presented. D.T.

N66-19752*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STRAIN MEASUREMENTS CONDUCTED ON A FULL SCALE ECHO II PASSIVE COMMUNICATIONS SATELLITE BALLOON
Charles L. Staugaitis and Lawrence Robren Washington, NASA, Mar. 1966 26 p refs
(NASA-TN-D-3126) CFSTI: HC $2.00/MF $0.50 CSCL 22B

A photogrammetric method and analysis for determining the strains developed in the skin of the Echo II passive communications satellite in a prelaunch static inflation test is described. The accuracy of these measurements is questionable due to the complexity of the strain pattern developed, however, a determination of the strain pattern set up in the skin of the balloon and reasons for their deviation from a balanced biaxial condition are examined. Comparison of these experimental strain measurements obtained by photogrammetric techniques with values determined from theoretical calculations and reasons for deviations are reviewed. Finally, tensile properties for the Echo II material obtained from biaxial bulge tests and tensile tests are measured and a comparison of these values with the actual performance of the balloon during the static inflation tests is discussed. Author

N66-20931*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE USE OF SHORT ARCS IN ORBIT DETERMINATION
Hans G. Hertz Washington, NASA, Mar. 1966 113 p refs
(NASA-TN-D-3172) CFSTI: HC $1.30/MF $0.75 CSCL 22C

At the IAF Congress in Stockholm in 1960, it was urged that osculating elements of satellite orbits be determined for individual station passages. This implied determinations from short arcs. The present investigation shows that, with the exception of the semi-major axis, the elements of the orbit of Echo I can indeed be determined from arcs with a half-arc length of $1^h.4$ to 4^h to the same accuracy as from conventional 1-day arcs. Several such determinations over an interval as short as 30 hours reveal deviations from gravitational behavior. Using 1-day arcs, such deviations can be readily found only from determinations spanning a longer interval. Author

N66-21645# Congress. Senate. Committee on Aeronautical and Space Sciences.
NATIONAL COMMUNICATIONS SATELLITE PROGRAMS
Washington, GPO, 1966 123 p Hearings before Comm. on Aeron. and Space Sci., 89th Congr., 2d Sess., 25–26 Jan. 1966 GPO: $0.35

This paper presents the hearings held before the Senate Committee on Aeronautical and Space Sciences to review the communications satellite programs, the relationship between government agencies on these programs, and the relationship between the government and the Communications Satellite Corporation. R.N.A.

N66-21691*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SYNCOM ENGINEERING REPORT, VOLUME I
Washington, NASA, Mar. 1966 165 p
(NASA-TR-R-233) CFSTI: HC $2.00/MF $1.00 CSCL 17B

This report is first of a planned series of reports on the Syncom satellite system. It is an engineering report covering the satellite, the communications ground stations and the telemetry and control ground stations. This report covers a description of each of the Syncom satellite system subsystems in addition to their operation and performance. The time period covered by this report is from launch through the first one hundred fifty days in orbit. Author

N66-21697*# TRW Systems, Redondo Beach, Calif.
NAVIGATION EXPERIMENT UTILIZING RELAY II SATELLITE
Washington, NASA, Apr. 1966 28 p
(Contract NAS5-9503)
(NASA-CR-429) CFSTI: HC $0.40/MF $0.50 CSCL 17G

Ranging measurements are reported from two different Relay II satellite passes over a target in a navigational experiment. The problem to utilize ranging data and orbital parameters for accurate localizations was first evaluated theoretically by error analysis, and the actual data were then compared with theoretical errors. It was concluded that an accurate station keeping system has to use range, azimuth, and elevation data in addition to an exact knowledge of the satellite orbit used. G.G.

N66-21704*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE SYNCOM III LAUNCH
Forest H. Wainscott Washington, NASA, Apr. 1966 14 p
(NASA-TN-D-3377) CFSTI: HC $0.20/MF $0.50 CSCL 22B

The Syncom III spacecraft was launched from Cape Kennedy, Florida on 19 August 1964 with the three stage thrust-augmented Delta vehicle configuration using the ABL X-258 solid propellant motor as the third stage. Through appropriate adjustment of the Delta powered flight, the transfer orbit, and the apogee motor boost direction, a synchronous orbit with a final inclination near zero degrees was achieved. Subsequent maneuvering with the satellite's on-board hydrogen peroxide jet control system reduced the orbital eccentricity to zero and located the spacecraft over the International Date Line. Author

N66-21773*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SATELLITE SITUATION REPORT, VOLUME 6, NO. 3
15 Feb. 1966 27 p Prepared in cooperation with NORAD and the Smithsonian Astrophys. Obs.
(NASA-TM-X-57324; X-512-66-51) CFSTI: HC $2.00/MF $0.50 CSCL 20A

Data were computed and compiled on objects in orbit from 1958 to 1200Z on February 15, 1966. The tabulations include the period, inclination, apogee, perigee, and transmitting frequency. N.E.N.

N66-21823*# RAND Corp., Santa Monica, Calif.
EARTH COVERAGE PATTERNS WITH HIGH-GAIN ANTENNAS ON STATIONARY SATELLITES
W. Sollfrey Feb. 1966 40 p
(Contract NASr-21)
(NASA-CR-71551; RM-4894-NASA) CFSTI: HC $2.00/MF $0.50 CSCL 09F

This memorandum presents coverage patterns which may be attained by the use of highly directive antennas on stationary communications satellites. The equations for the intersection of a sphere and a conical beam aimed at an arbitrary point on the sphere are set up and solved. The results are presented in graphic form. Coverage patterns are plotted on Mercator charts for antennas of 2° to 10° beamwidth aimed at points on the earth's surface offset from the subsatellite point by 0, 30, 45, and 60 great-circle degrees at various antenna azimuths. An overlay Mercator map of the earth is provided, which permits the user to find the effect of placing the satellite at different longitudes along the equator. As a typical result of the use of these curves, it has been found that the North Atlantic region can be covered from a satellite with a 7° antenna beamwidth at 58°W longitude looking at a point offset 45° with an azimuth of 75° north of east. The entire region visible to a synchronous satellite may be covered by a 17° beamwidth. Thus, a 7.7-db increase in antenna gain is available. The curves and overlay map permit the reader to find other possibilities. Author

N66-21829# Institute of Naval Studies, Cambridge, Mass.
CHANNEL CAPACITIES OF MULTIPLE/RANDOM ACCESS COMMUNICATIONS SATELLITE REPEATERS
David B. Newman May 1965 30 p refs
(Contract Nonr-3732(00))
(INS-RC-14; AD-627452) CFSTI: HC $2.00/MF $0.50

The channel capacity of a communication satellite repeater is of direct interest to all users in assessing how much service they may expect to obtain from a particular satellite or system. This is especially so when one considers that many users may attempt to gain access to a communication satellite simultaneously and without prior notice—the multiple and random access problem. The purpose of this paper is to present a method for estimating the channel capacities of various generic types of communication satellites which may be considered as alternates for successive generations of development. Author (TAB)

N66-21884# George Washington Univ., Washington, D. C.
AN ANALYSIS TO DETERMINE IF THE DEPARTMENT OF DEFENSE SHOULD OWN OR LEASE COMMUNICATIONS SATELLITES
Dondal Louis Steelman (M.S. Thesis) Sep. 1965 75 p refs
(AD-624678) CFSTI: HC $3.00/MF $0.75

Results of an analysis concerning the ownership and operation of communications satellite systems are presented. After a brief explanation of the nature of satellite communications, to orient the reader, the commercial and government needs and requirements for communications satellites are set forth, and the relationship of national policy to the communications Satellite Program are shown. An analysis of the alternatives for managing a global system to satisfy unique government requirements is summarized. M.R.W.

N66-22379*# Goodyear Aerospace Corp., Akron, Ohio.
FEASIBILITY STUDY AND PRELIMINARY DESIGN OF GRAVITY-GRADIENT-STABILIZED LENTICULAR TEST SATELLITE Interim Technical Report, Jul. 1963–Mar. 1964

1 Jun. 1964 750 p refs
(Contract NAS1-3114)
(NASA-CR-66053; GER-11502) CFSTI: HC $10.49/MF $3.50 CSCL 22B

The feasibility of a gravity–gradient stabilized, lenticular satellite for passive communications was established. Studies were based upon a lenticular reflector, having a 200 foot radius of curvature, which would provide horizon to horizon communications coverage at an orbital altitude of 2000 nautical miles. Key elements of the study, conducted in four phases, consisted of satellite stabilization, damping systems, orientation, microwave reflectivity, structural analyses, and the development of materials, packaging, and deployment concepts. Component and model tests were conducted to verify deployment concepts, microwave reflectivity theories, material photolyzation rates, and material and structural tests which did not require a zero gravity environment.
Author

N66-22658# Lincoln Lab., Mass. Inst. of Tech., Lexington.
THE EFFECT OF PSEUDORANDOM FREQUENCY HOPPING ON THE PROBABILITY OF SIMULTANEOUS USAGE OF A COMMUNICATION SATELLITE
John U. Beusch 22 Dec. 1965 32 p ref
(Contract AF 19(628)-5167)
(TN-1965-56; ESD-TDR-65-590; AD-627357) CFSTI: HC $2.00/MF $0.50

When the up-link frequency band repeated by a communications satellite is hopped in a periodic manner, when users are divided so that a group of them can transmit only when a particular frequency band is repeated, and when message arrivals for one user are independent of message arrivals for any other user, the users in a group are independent. When the frequency hopping is done in a pseudorandom rather than a periodic manner, the users are dependent. The effect of the dependence is, in practical cases, to increase the probability of there being a large number of simultaneous users which increases the probability of system overload. General expressions for the probability of system overload and for the fraction of the information lost due to overload are obtained. These expressions illustrate the effect of the dependence induced by the pseudorandom frequency hopping. Examples are presented.
Author (TAB)

N66-22806*# Goodyear Aerospace Corp., Akron, Ohio.
RADAR REFLECTIVITY TESTS AND ANALYSIS OF A LENTICULAR PASSIVE COMMUNICATION SATELLITE, APRIL–JULY 1965
Sep. 1965 73 p refs
(Contract NAS1-3114)
(NASA-CR-66051, GER-12330) CFSTI: HC $3.00/MF $0.75 CSCL 17B

Monostatic and bistatic radar reflectivity tests were conducted on gravity-gradient stabilized lenticular passive communications satellite models. The overall effects of the lenticule, booms, canister, and solar sails were determined. It was found that under the most adverse conditions, the relatively large, metallic, gravity-gradient booms caused some degradation of the return signal as compared to the lenticule alone. Reflectivity measurements to determine the electrical discontinuity effects of representative seams and materials were also carried out.
Author

N66-22807*# Goodyear Aerospace Corp., Akron, Ohio.
STUDY OF A PASSIVE COMMUNICATION, GRAVITY-GRADIENT STABILIZED, LENTICULAR SATELLITE Interim Summary Report, Jul. 1963–Dec. 1964
Jan. 1965 111 p refs
(Contract NAS1-3114)
(NASA-CR-66052; GER-11893) CFSTI: HC $4.00/MF $0.75 CSCL 22B

The feasibility of applying orbit position control and station-keeping to a gravity-gradient stabilized, lenticular, passive communications satellite has been demonstrated. The satellite mobility is realized by the action of direct solar pressure and thermal reradiation forces on surfaces having different optical characteristics. Several methods for rotating the satellite to aline the proper surface with respect to the sun were evaluated.
Author

N66-22824*# International Business Machines Corp., Rockville, Md. Federal Systems Div.
STUDY OF MODULATION TECHNIQUES FOR MULTIPLE ACCESS SATELLITE COMMUNICATIONS Final Report
25 Aug. 1964 175 p refs
(Contract NAS5-3544)
(NASA-CR-71164) CFSTI: HC $5.00/MF $1.00 CSCL 17B

This study was conducted to compare modulation techniques for voice communications using active synchronous satellite systems. The mathematical results used for the comparative analyses are discussed and are derived in detail in the appendices. Based on these results, several measures of comparison of modulation techniques are discussed using graphical data prepared from the theoretical equations as a source. Comparisons are made of the modulation techniques and system parameters. Conclusions, performance improving operations, the strong talkers problems, and recommendations are presented.
R.N.A.

N66-23446*# Goodyear Aerospace Corp., Akron, Ohio.
LENTICULAR COMMUNICATION SATELLITE WITH GRAVITY-GRADIENT STABILIZATION
Dec. 1965 31 p refs
(Contract NAS1-3114)
(NASA-CR-66054; GER-12367) CFSTI: HC $2.00/MF $0.50 CSCL 22B

The concepts, program development, and typical performance estimates of gravity-gradient stabilized, lenticular passive communication satellites are briefly described. Photolyzable film development and test data are outlined, and microwave analyses and tests are listed. Graphics illustrate the text. It was concluded that the satellite is feasible, and that materials, fabrication methods, and analysis techniques for the lenticular satellite concept are within the state-of-the-art. Findings also indicate: (1) The symmetrical boom system minimizes disturbing moments during satellite deployment. (2) Sails give less steady-state error and disturbing torques than opaque lens. (3) Radar reflectivity to weight ratio of the lenticular configuration is a significant improvement over passive sphere satellites for higher orbits.
M.G.J.

N66-23469*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PRELIMINARY ANTENNA DESIGN CONSIDERATIONS FOR A STADAN RELAY SATELLITE SYSTEM
W. F. Gabriel Mar. 1966 38 p refs
(NASA-TM-X-55441; X-520-66-107) CFSTI: HC $2.00/MF $0.50 CSCL 22B

A STADAN supplementary relay satellite system capable of direct two-way communication with instrumentation spacecraft is examined from an antenna system point of view. The required relay satellite antenna is of the simultaneous multiple-beam, wide-angle scanning, phase array type. Preliminary antenna design considerations indicate that such an antenna would be gain limited to approximately 30 db, and this gain limitation would not permit satisfactory operation with many present spacecraft which are typically of low radiated power. The concept becomes quite feasible in the 136 mc VHF band when spacecraft radiated power is increased to approximately 10 watts, and further system design-analysis for this band is recommended. Operation in the 400 mc band is also feasible for a spacecraft radiated power level of 10 or 20 watts, but the relay satellite antenna-receiver system becomes more complex and costly. S-band operation would be impractical for this general purpose concept because it would require the spacecraft to carry a moderately high-gain retrodirective antenna. Author

N66-23589*# Hughes Aircraft Co., Culver City, Calif. Space Systems Div.
ADVANCED SYNCOM: SYNCOM II SUMMARY REPORT
31 Mar. 1963 329 p refs
(Contract NAS5-2797)
(NASA-CR-74499; SSD-3128R) CFSTI: HC $7.00/MF $1.75 CSCL 22B

Spacecraft systems design, reliability, support equipment, alternate configurations, and other aspects are summarized for the Syncom II satellite which, exclusive of apogee motor, weighs 600 pounds when fully loaded with reaction jet control system propellants. Modes of operation and frequency and gain adjustment for the communication system are discussed, and various launch and orbit considerations are detailed. Advanced systems and their units are described and illustrated; and attention is given to axisymmetric vibrations, equations of motion, stress analysis, thermal control, and the apogee injection rocket motor. Reliability of systems, components, and materials is studied. Testing, weight and balance, and handling equipment is described; and the X3 multiplier and the output RF power switch are mentioned. A preliminary study of the radiation instrumentation payload for Syncom II is included. M.W.R.

N66-23590*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
ADVANCED SYNCOM, VOLUME 1 Summary Report
31 Oct. 1963 503 p refs
(Contract NAS5-2797)
(NASA-CR-74485; SSD-31118R, Vol. 1) CFSTI: HC $8.03/MF $2.50 CSCL 22B

System configuration and specifications are detailed for the advanced Syncom satellites. The spacecraft system is summarized. The capacity, quality, and operation of the communication system is discussed. The launch and in-orbit procedures and events were studied to facilitate the specification of procedural, performance, and spacecraft parameter requirements. The latest configuration and interconnection of the sybsystems, including all nonquadrant equipment and one set of quadrant equipment, are diagrammed. Reliability and quality assurance are discussed, and critical test plans outlined. The materials, processes, and components are tabulated. The system support equipment is described, including test plans, test equipment, major and minor control item test equipment, and ground control site equipment. Ground handling equipment design is also mentioned. N.E.N.

N66-23591*# Hughes Aircraft Co., Culver City, Calif. Space Systems Div.
ADVANCED SYNCOM. VOLUME 6: ENGINEERING DATA ON TRANSPONDER CONTROL ITEMS AND PHASED ARRAY Summary Report
29 Nov. 1963 111 p
(Contract NAS5-2797)
(NASA-CR-74503; SSD-31123R, Vol. 6) CFSTI: HC $4.00/MF $0.75 CSCL 22B

A detailed summary is presented of the engineering data for one set of frequency translation transponder control items for use with advanced Syncom satellites. Results are given for frequency translation testing at 6108 and 6212 mc, and thermal vacuum tests at the latter frequency. Performance test results are given for units which are common to both frequency translation and multiple access transponders, including ferrite switches, couples, multipliers, isolators, a local oscillator filter, and a traveling wave tube power supply. Specific units which are only in one of the types of transponders are considered, and numerous graphs and tables summarize performance results. Preliminary measurements with the phased-array antenna were undertaken, and the effect of phase errors is being studied. M.W.R.

N66-23850*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EXPERIMENTAL AND THEORETICAL EVALUATION OF A PASSIVE COMMUNICATIONS SATELLITE (ECHO II)
A. Kampinsky and R. K. Ritt (Conduction Corp.) Washington, NASA, May 1966 39 p refs Presented at the U.R.S.I. Symp. on Electromagnetic Wave Theory, Delft, Netherlands, 1965
(NASA-TN-D-3154) CFSTI: HC $2.00/MF $0.50 CSCL 22B

Pre-flight performances of a passive satellite communications system; the thin-wall-stressed-skin passive satellite (Echo II); and the correlation of post-flight data with preflight predictions are discussed. A schematic diagram of the Echo II balloon structure is given. Methods which were developed to predict the radar reflectivity of the Echo II communications satellite (which were subsequently used to analyze the data obtained during orbital flight), are described. The backscattering characteristics of a small segment of the large spherical structure was evaluated in terms of inherent distortions which can be related to physical construction or dynamic distortions in orbit. Other work described includes a postulation of a mathematical model of the balloon; a communications experiment; radar cross section statistics; fading rates; and signal modulation. Other details of the work are also reported. L.S.

N66-24431# Royal Aircraft Establishment, Farnborough (England).
THE COMMUNICATIONS SATELLITE, MOLNIYA 1 Current Information on Russian Research and Development
16 Jun. 1965 10 p Transl. into ENGLISH from Pravda (Moscow), 30 May 1965
(RAE-LIB-TRANS-76)

The method of orbital insertion, orbital parameters, physical description, and operation capabilities are given for the Soviet communications satellite, Molniya I. Among the points discussed in the narrative account were: (1) The final orbit was achieved by thrusting from an intermediate low orbit, and is maintained against perturbations and in optimum signaling position by an on-board rocket motor. (2) Satellite positioning relative to the sun is accomplished by a solar battery. (3) Retransmission equipment handles television, telephone, and telegraph communications. (4) Radiation

measurements and effects and operating conditions are reported by a telemetry system. (5) Testing has been done for the transmission of color television by the Secam system. E.A.O.

N66-24500*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.

ADVANCED SYNCOM. VOLUME 4: SYSTEM AND SUBSYSTEM PERFORMANCE REQUIREMENTS Summary Report

31 Oct. 1963 72 p

(Contract NAS5-2797)

(NASA-CR-74580; SSD-31121R) CFSTI: HC $3.00/MF $0.75 CSCL 22B

System and subsystem performance specifications for the Advanced Syncom satellite are presented both in descriptive and tabulated form. Requirements are given for the spin speed control and resolution; spin stabilization and maintenance; weight; balance; dimensions; vibration; telemetry; loading; thermal environment; communications; command; pressure; nutation; orbit; structure; and other factors entering into the designing of a structural engineering model of Advanced Syncom. A photograph of this model is given, along with a schematic diagram showing the general internal arrangement of the satellite. L.S.

N66-24513*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

SYSTEMS COMPARISON OF DIRECT AND RELAY LINK DATA RETURN MODES FOR ADVANCED PLANETARY MISSIONS

T. A. Barber, J. M. Billy, and R. D. Bourke 15 Feb. 1966 81 p refs

(Contract NAS7-100)

(NASA-CR-74653; JPL-TM-33-228) CFSTI: HC $3.00/MF $0.75 CSCL 17B

This report analyzes advanced planetary missions using a Saturn IB and simultaneous orbiting and landing spacecraft. An analysis of the relative data return capability of two alternate modes is given. One mode (named the relay link) uses transmission of the lander produced data to a planetary relay communications satellite, then transmission to the Earth; the other (named the direct link) uses transmission directly from the lander to the Earth. Numerical results are given for sample advanced planetary missions to Mars. Author

N66-24939*# Space Technology Labs., Inc., Redondo Beach, Calif.

STUDY OF SPACECRAFT TRANSPONDER POWER AMPLIFIER Final Report

R. R. Cagnon, K. E. Lytal, and S. D. Mc Caskey Aug. 1964 200 p refs

(Contract NAS5-3423)

(NASA-CR-74775; STL-4104-6001-RU-000) CFSTI: HC $5.00/MF $1.25 CSCL 09F

This report covers a study program conducted to investigate the feasibility of a wideband, direct RF to RF conversion communication satellite transponder, utilizing a TWT in a reentrant mode. After amplification by the TWT, the signal(s) are frequency translated and reamplified by the same TWT. Pre- and post-amplification is provided to establish system sensitivity and dc to RF conversion efficiency. The optimum transponder type and configuration was determined, fabricated, and evaluated. Analysis of the measured performance is presented with emphasis on the baseband distortion characteristics for both single and multiple signals. Unusual characteristics of the TWT as operated in the re-entrant mode are also analyzed and presented. The gain, output power, and noise figure obtained with the re-entrant transponder were established to be consistent with the basic requirements of a communication satellite. The major advantage offered is reduced transponder complexity and the extremely wide bandwidths which can be realized. Author

N66-25549*# National Aeronautics and Space Administration, Washington, D.C.

COMMUNICATIONS SATELLITES Bibliography, Feb. 1965–Jan. 1966

May 1966 85 p refs

(NASA-SP-7004(02)) CFSTI: HC $1.00/MF $0.75 CSCL 22B

An annotated bibliography on communications satellites is presented with abstracts, and author and subject indexes. Such diverse topics are referenced as: television broadcasting, telemetry, outer-space systems, multi-station systems, and medium height random orbit systems. The economic and legal implications of communications satellites are represented. References are also included which describe the history and operation of individual satellites as Advent, Courier, Echo, Relay, Score, Syncom, and Telstar, and well as several satellites used for meteorological studies. D.T.

N66-25619# Naval Research Lab., Washington, D. C.

IONOSPHERIC PARAMETERS DERIVED FROM ECHO II RADAR RETURNS DURING SOLAR MINIMUM CONDITIONS Interim Report

John M. Goodman 21 Feb. 1966 22 p refs

(NRL-6375; AD-630142) CFSTI: HC $1.00/MF $0.50

Radar returns from the Echo II satellite (1964-4A) were analyzed for Faraday rotation effects in order to ascertain their utility in deducing both the subsatellite electron content and the equivalent slab thickness of the daytime ionosphere. The following conclusions were reached: (a) The subsatellite electron content generally exhibits a large variance, but its average value tends to be largest near midday and decreases with increasing solar zenith angle. (b) The daily equivalent slab thickness exhibits no marked variation between 0800 and 1800 EST, although midafternoon values are somewhat in excess of prenoon values. (c) The seasonal equivalent slab thickness has its minimum in local winter and its maximum in local summer; the equinox values are intermediate, with the autumnal equinox exhibiting higher computed values than the vernal equinox period. (d) The mean scale height Hs and the mean neutral gas temperature T for the ionosphere were found to be 94 km and 1582° K, respectively, during daytime hours. The daytime ionosphere was found to be 500° K warmer in summer than in winter, with the mean equinox temperature being close to the all-season average. (e) No pronounced correlation with Zurich sunspot number of decimetric solar flux was discernible, which was probably due to the fact that statistical variations in the observations exceeded the real variations which might have occurred as a result of solar activity changes. (f) No correlation with the magnetic index K was noted. These conclusions are based on radar echo data obtained during the recent period of minimum solar activity. Author (TAB)

N66-27275# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

STRUCTURAL CONSIDERATIONS FOR AN EXPANDABLE LENTICULAR SATELLITE

Jerry L. Humble *In* AFSC, Wright-Patterson AFB, Ohio Aerospace Expandable Struct. [1966] p 199–213 (See N66-27266 15-32) CFSTI: HC $11.00/MF $3.25

The structural concepts and considerations are presented for a lightweight, expandable lenticular passive communications satellite. In addition, the satellite is to be gravity gradient stabilized and is to have orbital position control capability. It is noted that preliminary investigations indicate the feasibility of the total lenticular concept. It was also demonstrated that using the lenticular shape a passive communications satellite can be produced with capabilities superior to those of a spherical satellite of the same weight. The various materials and loads which may be used in the construction of a lenticular satellite are discussed, along with the packaging and deployment procedures and operations. D.T.

N66-27293# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FABRICATION AND PRESSURIZATIONS TECHNOLOGY FOR IMPROVEMENT OF SURFACE ACCURACY OF PASSIVE COMMUNICATIONS SATELLITES
David C. Grana and Walter E. Bressette *In* AFSC, Wright-Patterson AFB, Ohio Aerospace Expandable Struct. [1966] p 603–616 ref (See N66-27266 15-32) CFSTI: HC $11.00/MF $3.25

The errors inherent in the fabrication technique, improved manufacturing procedures, and the effect of the number of gores are reviewed. The strain in the satellite material is described theoretically, and an expression is developed for the strain in terms of the number of the gores. A formula is also presented for the inherent error in terms of width and number of gores. Experimental details are given for the photogrammetric measurements of 12 ft spheres with 32, 48, and 64 gores at low and high pressures, and the results are plotted. Among the conclusions are: the permanent strain required to strain an approximate sphere to spherical shape is dependent only upon the number of gores and decreases with an increased number of gores; stress–strain data obtained by a biaxial diaphragm technique agreed with the easier to obtain Instron data; and the strain required to remove the maximum expected fabrication errors varied from pole to equator by as much as a factor of 10 with the pole area requiring the greatest correction. N.E.N.

N66-27294# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MEMBRANE ANALYSIS OF PRESSURIZED THIN SPHEROID SHELLS COMPOSED OF FLAT GORES, AND ITS APPLICATION TO ECHO II
Hossein Bahiman and John M. Thole *In* AFSC, Wright-Patterson AFB, Ohio Aerospace Expandable Struct. [1966] p 617–631 refs (See N66-27266 15-32) CFSTI: HC $11.00/MF $3.25

The computation of the shape of the pressurized shell is based on the solution of five nonlinear partial differential equations of equilibrium and boundary conditions for the three displacements of a gore. The approximate solution of the equations by perturbation technique was performed, and resulted in three displacement functions of the gore with one unknown constant. This constant was evaluated by applying the variational method to the total elastic strain and potential energy of the system. It was assumed that the displacement of the spheroid due to the gravity is negligible compared to the one caused by the constant internal pressure, and that the material of the spheroid is homogeneous and isotropic, and obeys Hooke's law. It is concluded that this technique gives a good approximation of the maximum differential radial displacement of a pressurized spheroid in a zero gravity field. N.E.N.

N66-28333# Royal Aircraft Establishment, Farnborough (England).
EXOSPHERIC DENSITIES NEAR SOLAR MINIMUM DERIVED FROM THE ORBIT OF ECHO 2
G. E. Cook and Diana W. Scott Mar. 1966 32 p refs
(RAE-TR-66105) CFSTI: HC $2.00/MF $0.50

The density of the upper atmosphere at heights between 1080 and 1170 km is evaluated from the change in the orbital period of Echo 2 for dates between February 1964 and December 1965. The air density shows a pronounced semiannual variation, while the variation between day and night is unlikely to exceed a factor of 2. Author

N66-29397*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A PHASED ARRAY ANTENNA SYSTEM FOR COMMUNICATION SATELLITES
William Korvin and George G. Chadwick (Radiation Systems, Inc.) [1965] 53 p refs Submitted for Publication
(NASA-TM-X-56896) CFSTI: HC $3.00/MF $0.50 CSCL 09F

Antenna pattern coverage requirements for communication satellites under various altitude and attitude conditions are reviewed, and characteristics of some practical antenna designs are considered. The theories of cylindrical array and 12-element planar array systems are analyzed, and their geometries are discussed. Based on these data, an engineering model of a multibeam, high gain, 4π steradians coverage antenna system was developed and tested to demonstrate the feasibility of the theory. Block diagrams and measured characteristics are given to explain its operation. It was concluded that the model most nearly satisfies the following requirements for a multipurpose antenna system: high gain and some discrimination against electrical interference, circular polarization, frequency bandwidth of 15% to 25%, ability to receive or transmit in multiple directions either simultaneously or with nanosecond switching time over 4π steradians of space, kilowatt peak power handling capacity, compact size, low drive power for phasing devices, and radiating elements that conform to the diameter of the satellite. L.E.W.

N66-29791# ITT Federal Labs., Nutley, N. J.
DATA BUFFERING TECHNIQUES STUDY Second Quarterly Report, 1 Jan.–31 Mar. 1966
[1966] 21 p refs.
(Contract DA-28-043-01471(S))
(Rept.-5; AD-631497) CFSTI: HC $1.00/MF $0.50

The purpose is the performance of a study of techniques and equipment for the accomplishment of data buffering to correct data flow for varying range and range rates of satellite repeaters. The program is divided into four phases; investigation and selection phase, design and fabrication phase, test and performance phase, and engineering design phase. A design was evolved for a controlled data buffering system breadboard capable of correcting data flow for varying range and range rates of satellite repeaters. Based on the design layouts, block diagrams, logic diagrams and printed circuit artwork were made, and components ordered. Fabrication of the breadboard is in process. A four-stage test plan has been developed. TAB

N66-29960# Sichak Associates, Nutley, N. J.
COHERENT FOCUSING RADAR (COFFER) Final Report
Griffiss AFB, N. Y., RADC, Apr. 1966 63 p refs
(Contract AF 30(607)-3492)
(RADC-TR-65-517; AD-632218) CFSTI: HC $3.00/MF $0.75

An Echo II tracking experiment was attempted using the coherent focusing radar (COFFER) system developed under contract AF 30(602)-2750. The objective was to investigate acquisition time, coherency of focus and tracking capability of the equipment when used with a satellite target. The COFFER equipment was previously optimized for aircraft targets and depended on externally supplied look angles from another radar for target acquisition. For use with Echo II, the system was modified somewhat and an optical tracking subsystem was added for aid in acquisition. However this method of acquisition was effective only during visual passes of the satellite in good weather which did not prevail during the time available. Only limited results were obtained for this reason. Author (TAB)

N66-30182*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE EQUATORIAL ELLIPTICITY OF THE EARTH FROM TWO MONTHS OF SYNCOM II DRIFT OVER THE CENTRAL PACIFIC

C. A. Wagner Washington, NASA, Jul. 1966 44 p refs (NASA-TN-D-3315) CFSTI: HC $2.00/MF $0.50 CSCL 08N

This is the second in a series of reports on the use of tracking information from Syncom II satellite to define the longitude-dependent gravity field of the earth. This tracking information shows that Syncom II drifted freely in the gravity fields of the earth, sun, and moon from 25 April to 3 July 1964. In early May, the ascending equator crossing of the orbit, as determined from radar range and range-rate tracking, was at 121° west, with a westward drift rate of 0.81 degrees/day. During the following two-month period, this drift rate decreased steadily until late in June when, with the ascending equator crossing at 161° west, the westward drift rate was 0.75 degrees/day. This decelerating drift rate is entirely consistent with the magnitude and phase angle of the equatorial ellipticity of the earth, as previously determined by this author. These ellipticity constants were responsible for the accelerated drift of this satellite in the longitudes from 55° to 64° west. By utilizing the first (energy) integral of the drift motion of a 24-hour satellite in a second-order longitude-dependent earth gravity field, the drift of Syncom II over the Central Pacific during the two months in question was seen to be sensitive to parameters of the earth's equatorial ellipticity: $J_{22}=-(1.71 \pm 0.22)\times 10^{-6}$, which corresponds to a difference in the major and minor equatorial axes of the earth of $a_0-b_0=214\pm 28$ feet, and $\lambda_{22}=-(17.1 \pm 4.9)$ degrees, which gives the longitude of the major equatorial axis with respect to Greenwich. Author

N66-30255*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE EQUATORIAL ELLIPTICITY OF THE EARTH AS SEEN FROM FOUR MONTHS OF SYNCOM II DRIFT OVER THE WESTERN PACIFIC

C. A. Wagner Washington, NASA, Jul. 1966 32 p refs (NASA-TN-D-3313) CFSTI: HC $2.00/MF $0.50 CSCL 08E

Tracking information from Syncom II satellite is used to define the longitude-dependent gravity field of the earth. This set of orbit data shows that the westward drift of Syncom II decelerated from 0.480 degrees/day at a nodal longitude of −174.35° in early July 1964, to 0.446 degrees/day at a longitude of 159.53° in late August 1964. Further westward drift of the satellite resulted in an acceleration of the westward drift rate to 0.501 degrees/day when Syncom II reached a mean longitude of 134.22° in early November 1964. On the assumption that this four-month drift of Syncom II was sensitive to only second-order longitude-dependent earth gravity (associated with the ellipticity of the earth's equator), as well as sun, moon and ordinary earth zonal gravity forces, the magnitude and orientation of such equatorial ellipticity is calculated as $J_{22}=-(1.86 \pm .14)\times 10^{-6}$, which corresponds to a difference in major and minor equatorial radii of the earth of $a_0-b_0=234 \pm 18$ ft, and $\lambda_{22}=-(16.6 \pm 2.9)°$, which locates the longitude position of the major equatorial axis with respect to Greenwich. Author

N66-30332*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

LONG PERIOD LUNAR AND SOLAR EFFECTS ON THE MOTION OF RELAY 2

Theodore L. Felsentreger Mar. 1966 46 p refs (NASA-TM-X-55509; X-547-66-102) CFSTI: HC $2.00/MF $0.50 CSCL 03B

Long period perturbations in the orbital elements of Relay 2, arising from luni-solar gravitation and solar radiation pressure, are analyzed. An analysis is presented of the effects on the eccentricity and inclination caused by the existence of a near-resonant condition in two of the trigonometric terms in the luni-solar disturbing function. Author

N66-30384*# American Telephone and Telegraph Co., New York.

COMMUNICATIONS PROGRESS AND PROBLEMS

Richard R. Hough *In* NASA, Washington Proc. of the 5th Natl. Conf. on the Peaceful Uses of Space 1966 p 145–148 (See N66-30366 17-30) GPO: HC $1.50; CFSTI: MF $1.25

A brief overall view on the growth of communications media and their connected technological innovations is presented, with emphasis on communications satellites. New developments in microwave transmission, transistors, solar batteries, masers, negative feedback, switching circuits, and microminiaturization techniques play an important role in the economics of continuous communications services and the exploration of space. G.G.

N66-30385*# Radio Corp. of America, New York.

FUTURE IMPLICATIONS OF COMMUNICATIONS TECHNOLOGY

Elmer W. Engstrom *In* NASA, Washington Proc. of the 5th Natl. Conf. on the Peaceful Uses of Space 1966 p 149–154 (See N66-30366 17-30) GPO: HC $1.50; CFSTI: MF $1.25

The impact of space satellites on worldwide communications systems and their role as relays across transoceanic or transcontinental distances is projected. Linking of computers with wideband, high capacity, two way communications facilities will it make possible to pipe communications services such as television, FM radio programs, and even high speed facsimile newspapers directly into homes. This system could carry telephone conversations in sight and sound, could be used in sampling, voting, and opinion taking surveys, as well as to provide direct access from the home to electronic libraries, stores, theaters, public facilities, etc. A system of broadcasting directly from satellites to television receivers can be a powerful agent for teaching over large areas of the globe. G.G.

N66-30386*# St. Louis Univ., Mo.

THE ROLE OF THE SOCIAL PHILOSOPHER IN THE SPACE AGE

Robert J. Henle *In* NASA, Washington Proc. of the 5th Natl. Conf. on the Peaceful Uses of Space 1966 p 155–157 (See N66-30366 17-30) GPO: HC $1.50; CFSTI: MF $1.25

New communications capabilities—encompassing telephones, computer storage of knowledge, printouts, television across the world, etc.,—will make human participation in actual events as they occur possible, and at the same time give future generations a relationship with the past that will almost approach a living participation. Human values should be used to manage and manipulate these new technologies to insure the future welfare and happiness of all mankind. G.G.

N66-31097# RAND Corp., Santa Monica, Calif.
ECONOMIC PROBLEMS OF ESTABLISHING A COMMUNICATIONS SATELLITE SYSTEM
Leland L. Johnson Oct. 1962 10 p Presented at the Subcomm. on Monopoly of the Senate Select Comm. on Small Business, 3 Aug. 1961
(P-2647; AD-625351) CFSTI: HC $1.00/MF $0.50

Four types of monopolistic ownership for a U.S. Satellite System are considered: (1) system owned and operated exclusively by U.S. international common carriers; (2) system owned and operated by these carriers and satellite equipment manufacturers; (3) system owned by neither of these but by a diversity of stockholders who generally have no direct business ties in the communications field, this firm selling voice channels to the common carriers; and (4) a system owned and operated by the government that would sell channels to common carriers. The U.S. is stated to have the problem of deciding whether: (1) to develop a system for a large number of countries, particularly underdeveloped ones, this probably including a large number of satellite ground stations in many smaller nations; or, (2) to establish relatively few large ground stations around the world in major population centers in order to tie together the major land masses and then connect the underdeveloped countries into the worldwide system by conventional land line. TAB

N66-31161*# Lafayette Coll., Easton, Pa.
DEVELOPMENT OF THE 10.6-MICRON LASER
Zbigniew D. Jastrzebski *In* NASA. Goddard Space Flight Center ASEE–Univ. of Md.–Catholic Univ. NASA Summer Fellowship Program Jan. 1966 p 95–96 (See N66-31154 17-07) CFSTI: HC $4.00/MF $0.75

Work was initiated on the development of a 10.6 micron nitrogen–carbon dioxide laser to be used in an optical tracking system for communication between the ground stations and the Echo II satellite. Two experimental setups, which, with respect to the Vycor discharge tube, differed in the mirror arrangement, were designed. In one setup the gold plated mirrors form an integral part of the laser assembly, being vacuum-tight connected to the ends of the discharge tube through metallic bellows. In the second the gold plated mirrors are located externally to the discharge tube, which is terminated by vacuum tight Brewster angle windows. These windows and one of the two gold plated mirrors are made of barium fluoride. This mirror has a one millimeter diameter hole in the gold coating for coupling out the radiation; the other mirror is one hundred percent opaque. The discharge tube is connected through an outlet with the manifold of the vacuum system so that it is possible to control precisely low partial pressures of the gaseous ingredients. Qualitative measures for the detection of the infrared laser beam were performed. D.T.

N66-31213*# Collins Radio Co., Cedar Rapids, Iowa.
SIGNAL FADING CHARACTERISTICS, ECHO II
Washington, NASA, Jul. 1966 108 p
(Contract NAS5-9648)
(NASA-CR-528) CFSTI: HC $4.00/MF $0.75 CSCL 17B

This report contains an analysis of the fading of the Echo II satellite radio cross section. Fade duration and fade period probability distribution and density functions were obtained at various cross section levels. The results of the analysis indicate that the fading characteristics of Echo II did not change noticeably over the first year from launch. The fading of Echo II is similar to that observed on other communication links. Author

N66-31339# Institute for Defense Analyses, Arlington, Va. Research and Engineering Support Div.
ON NORMAL APPROXIMATIONS TO THE ERROR PROBABILITY FOR A CORRELATION RECEIVER IN A HARD-LIMITED CHANNEL
Joseph M. Aein Jan. 1966 44 p refs
(Contract ARPA SD-50)
(P-241; IDA/HQ-66-4565; AD-632917) CFSTI: HC $2.00/MF $0.50

The advent of communication satellites has stimulated interest in signal designs allowing access to a repeater by many independent carriers. To maximize the power efficiency of the satellite, consideration has been given to the use of a repeater which can be characterized as a hard-limited channel. A technique for achieving multiple access to a hard-limited channel is to use constant-envelope, pseudo-noise phase-coded spread-spectrum carriers (p-n carriers) with correlation-type receivers. The interferring signals at the limiter input are modeled as a statistically independent zero mean stationary Gaussian noise process. This paper examines the approximation to normal of the error probability when binary symmetric bit-to-bit independent message sources are received by a coherent stored reference correlator after passing through a hard-limited channel. The approach used here follows that of Shannon and Gallagher for computing the probability tail with Chernoff bounding techniques. This method avoids the usual objections raised to the Edgeworth series when used to compute an error probability. Subject to restrictions of weak carrier-to-noise ratios at the channel input and error rates less than 10^{-2}, the conclusion reached is that the error probability can be computed, to within the accuracy of the mathematical idealization of a real channel, as if the correlator output were normal. Author (TAB)

N66-31922# Radio and Space Research Station, Slough (England).
KINETHEODOLITE OBSERVATIONS OF SATELLITES RECEIVED BY THE SATELLITE ORBITS GROUP FROM MALTA FOR JANUARY AND FEBRUARY 1966
[1966] 38 p *Its* Issue No. 11
CFSTI: HC $2.00/MF $0.50

Kinetheodolite data of the Transit 2A (1960-07A, Eta 1), Courier 1B (1960-13B), Midas 4 (1961-28A), Transit 4B (1961-31C), Ariel 1 (1962-15A), Alouette (1962-49B), Injun 3 (1962-67B and 67F), and Thor Agena D (1963-03A) satellites as observed from Malta during January and February of 1965, are presented. The time, azimuth, and elevation tables are also given for the Explorer 17 (1963-09A), Geophysics Research (1963-26A), Thor Agena B (1963-27A), Polyot 1 (1963-43A), Ablestar (1963-49A), Explorer 19 (1963-53A), Thor Agena D (1964-11A), Elektron 3 (1964-38A), Cosmos 44 (1964-53A), Thor Agena (1964-72A), and Explorer 24 (1964-76A) satellites. L.S.

N66-32016*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
HYPOTHETICAL FOUR-BODY PROBLEM AND ITS APPLICATIONS: AN ESTIMATE OF THE EFFECT OF THE MOON AND THE SUN ON THE SYNCOM ORBIT

Su-shu Huang *In its* Publ. of Goddard Space Flight Center, 1963, Vol. I [1963] p 260–268 refs (See N66-32006 18-30) GPO: HC $9.75; CFSTI: MF $7.50

A hypothetical system has been constructed by assuming that the center of mass of two finite bodies which are revolving around each other in circular orbit is itself circling with a third finite body at a large distance around the center of mass of the entire system. This somewhat artificial system is an idealization of the earth–moon–sun system. Thus, any satellite that moves in the latter system may be treated, as an approximation, as an infinitesimal fourth body in the hypothetical system, thereby constituting a hypothetical four-body problem. An investigation of the energy integral of the hypothetical four-body problem confirms that the motion of an artificial satellite in the earth–moon–sun system may be treated with a good approximation, as two three-body problems. An application of the problem thus formulated is found in the study of the general behavior of the Syncom orbit in the presence of the moon as well as the sun. It appears that the presence of both destroys the perfect synchronization of the axial rotation of the earth and the revolution of the Syncom satellite around it. It appears that the period of the fourth body around the earth fluctuates with the relative motion of the sun with respect to the earth–moon system. However, the deviation from the perfect synchronization is exceedingly small as would be expected and has no practical significance. Author

N66-32044*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PUBLICATIONS OF GODDARD SPACE FLIGHT CENTER, 1963. VOLUME II: SPACE TECHNOLOGY

[1963] 1084 p refs

(NASA-TM-X-57738) CFSTI: HC $7.00/MF $5.00 CSCL 22B

Articles on spacecraft and subsystems, vehicle technology, sounding rockets, sensors, environmental testing, and tracking systems are presented. For individual titles see N66-32045–N66-32081.

N66-32045*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

STEREO PHOTOGRAPHY OF THE ECHO II BALLOONS NUMBER 9, 11, AND 13

Sol H. Genatt *In its* Publ. of Goddard Space Flight Center, 1963, Vol. II [1963] p 22–31 (See N66-32044 18-31) CFSTI: HC $7.00/MF $5.00

A description is given of the equipment and technique used to determine the deviation from sphericity of the skin of three Echo II balloon satellites at varying skin pressures. Diagrams and photographs illustrate the instrumental setup and the results of the stereophotography. Author

N66-32046*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

RELAY

Robert H. Pickard and Sidney Metzger (Commun. Satellite Corp.) *In its* Publ. of Goddard Space Flight Center, 1963, Vol. II [1963] p 105–110 (See N66-32044 18-31) CFSTI: HC $7.00/MF $5.00

The communications satellite Relay I subsystems are described and their performances during 499 operations are evaluated. This orbiting spacecraft provided an experimental microwave repeater for transmission of TV signal or 600 voice channels that can also be utilized for high speed data, facsimile, or teletype traffic with bandwidths of up to 4 Mc. System demonstration experiments, emphasizing quality television and telephony, established good multiburst signals. EIA test patterns, bar and window patterns, and good quality pictures; results on two way multiple channel phone calls between the United States and Europe indicated severe echo problems that make echo suppression techniques mandatory. Spacecraft tracking with narrow beamwidth antennas provided accurate prediction data for programmed steering. It was concluded that satellite born microwave repeaters can provide high quality wideband communication service in a stable predictable manner. G.G.

N66-32047*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

RELAY I SPACECRAFT PERFORMANCE

Robert H. Pickard *In its* Publ. of Goddard Space Flight Center, 1963, Vol. II [1963] p 111–121 (See N66-32044 18-31) CFSTI: HC $7.00/MF $5.00

This paper describes RELAY I, an experimental communications spacecraft. Factors leading to the design of an experimental communications satellite are considered. Limitations in the bandwidth of available klystrons for ground transmitters required the use of modulation index tripling in the spacecraft to obtain usable signal to noise ratios on the spacecraft to ground path. Simultaneous two-way telephone experiments required that two separate IF channels be provided to prevent signal suppression and to reduce cross modulation products. It was necessary to provide 20 command channels and 128 multiplexed PCM telemetry channels to operate the spacecraft and evaluate its performance. Prelaunch performance evaluation of the communications equipment consisted of measuring parameters such as S/N ratio, group delay, noise loading, bandwidth; cross talk, frequency, and power output. A summary of experimental results obtained from in-orbit operations indicates close correlation to prelaunch measurements. Illustrations of experimental results are given. Author

N66-32048*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

RELAY, AN EXPERIMENTAL SATELLITE FOR TV AND MULTICHANNEL TELEPHONY COMMUNICATIONS

Robert H. Pickard, S. Roth, and J. Kiesling *In its* Publ. of Goddard Space Flight Center, 1963, Vol. II [1963] p 122–140 (See N66-32044 18-31) CFSTI: HC $7.00/MF $5.00

Design details of the Relay communications repeater satellite and its mission objectives are outlined. The primary function of the Relay satellite is to investigate the technological problems of wideband transmission and to develop operational experience for satellite communications systems. The spacecraft weighs 170 pounds and will be launched by a Delta vehicle; its power supply consists of a solar cell array and hermetically sealed nickel cadmium storage batteries. The communication system used in the Relay spacecraft is composed of the following three major subsystems: (1) wideband communications; (2) telemetry; and (3) command control. Its main components are a slotted antenna array for telemetry and command mounted on top of the spacecraft, a solid receiver with varacter multipliers and IF branching, and a traveling wave tube amplifier designed to operate in the vacuum environment of outer space. Performance data for some typical links are shown in a table, and some future radiation detection experiments are briefly discussed. G.G.

N66-32055*# General Mills, Inc., Minneapolis, Minn. Electronics Div.

CHARACTERISTICS OF PASSIVE COMMUNICATION SATELLITES WITH LAMBERTIAN SURFACES

Herbert P. Raabe *In* NASA. Goddard Space Flight Center Publ. of Goddard Space Flight Center, 1963, Vol. II [1963] p 346–356 refs Presented at the 13th Intern. Astron. Congr., Varna, Bulg., 28 Sep. 1962 (See N66-32044 18-31) CFSTI: HC $7.00/MF $5.00
(Contracts NAS5-890; NAS5-1598)

Passive Communication Satellites with surfaces reflecting diffusely according to Lambert's law are particularly attractive since they afford a directional pattern well matched to the optimum pattern of satellites in lower orbits and since such surfaces are easily realized. The echo from diffuse reflectors varies statistically, and a combination diversity technique of frequency should be used to stabilize the signal. A spherical satellite is no longer required; and weight reduction and higher reliability can be gained from polyhedral structures. Compared with a rigidized specularly reflecting sphere, a Lambertian reflector affords a 7 db stronger echo for the same weight. Model tests of reflectivity agree well with the theory. Author

N66-32106*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON THE PROBABLE INFLUENCE OF HIGHER ORDER EARTH GRAVITY IN THE DETERMINATION OF THE EQUATORIAL ELLIPTICITY OF THE EARTH FROM THE DRIFT OF SYNCOM II OVER BRAZIL
C. A. Wagner Washington, NASA, Aug. 1966 25 p refs
(NASA-TN-D-3314) CFSTI: HC $1.00/MF $0.50 CSCL 08N

This document gives calculations from the best available geodetic sources showing that the Syncom II–Brazil second-order earth gravity experiment reported earlier by this author probably contained a small but significant bias due to higher order earth gravity. This bias is estimated by "extrapolation" from these sources. Bounds on the true ellipticity of the earth's equator are derived by combining the best estimate of this bias with the actual Syncom II drift measurements. These bounds, though somewhat wider than measured by Syncom II (over Brazil) alone, should be absolute and the target for all future investigations into longitude-dependent earth gravity. Author

N66-32258*# Schjeldahl (G. T.) Co., Northfield, Minn.
DEVELOPMENT OF A 425 FOOT DIAMETER PASSIVE COMMUNICATION SATELLITE WITH SELF-ERECTING PROPERTIES Quarterly Progress Report No. 8 and Monthly Progress Report, May 1966
William Jacobi [1966] 36 p
(Contract NAS5-3943)
(NASA-CR-76677) CFSTI: HC $2.00/MF $0.50 CSCL 22B

Progress is reported on a program to develop a material with the ability to erect without an inflation system or external aids, with an open mesh configuration 90% transparent to solar radiation, with sufficient rigidity to withstand solar pressure having a safety factor of 5.0, and an RF reflectivity 95–98% that of a similar solid surface. During this period various sizing materials were investigated and the results are presented. An experiment was designed to determine the heat treatment required for highest rigidity. Results of a preliminary study of vacuum deposited aluminum as the conductive coating are included. A method for evaluating the rigidity after folding was developed and the test results are presented. High speed motion pictures were made of several cylinders to examine the material during deployment. R.N.A.

N66-32945*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ANALYSIS OF LUNAR AND SOLAR EFFECTS ON THE MOTION OF CLOSE EARTH SATELLITES
James P. Murphy and Theodore L. Felsentreger Washington, NASA, Aug. 1966 78 p refs
(NASA-TN-D-3559) CFSTI: HC $2.50/MF $0.75 CSCL 22A

Theoretical and experimental studies indicate that long periodic lunar and solar forces produce perturbations in the orbital elements of close earth satellites comparable to perturbations caused by the earth's oblateness. Analytic formulas for secular and long-period luni-solar gravitational perturbations, as well as long-period expressions for solar radiation pressure effects (neglecting the earth's shadow), are given. A program for computing luni-solar perturbations was written and it was used to analyze the motion of the Relay 1 (1962 B, Upsilon 1) and Telstar 2 (1963 13A) satellites. Author

N66-33181*# RAND Corp., Santa Monica, Calif.
COMMUNICATION SATELLITE OUTPUT DEVICES
N. E. Feldman Sep. 1964 39 p refs Submitted for Publication
(Contract NASr-21-02)
(NASA-CR-59580) CFSTI: HC $2.00/MF $0.50 CSCL 17B

This report reviews and quantitatively compares the various categories of solid state and vacuum tube output devices for communication satellites. Emphasis is placed on the relative ability of semiconductor devices, such as tunnel diodes, transistors, and varactor diodes; and vacuum tube amplifiers, such as triodes, klystrons, amplitrons, and traveling wave tubes, to generate power efficiently at frequencies of 1 to 10 kMc and power levels of 0.1 to 100 watts. R.N.A.

N66-33288# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
MARK IV TERMINAL Final Report
Apr. 1965 251 p refs
(Contract DA-28-043-AMC-00121(S))
(SSD-5165R; AD-633560) CFSTI: HC $6.00/MF $1.50

The success of the NASA/Hughes Syncom satellite program created interest regarding the feasibility of a fully operational system of synchronous satellites encircling the earth to provide instant communications 24 hours per day. Such a system was desirable for not only its inherent commercial capabilities, but also as a strategic communications network for military utilization. The U.S. Army (SATCOM Agency at Fort Monmouth, New Jersey) initiated a feasibility investigation. Because of the requirement for any communications satellite to transmit to and from ground stations, the most critical requirement was that of a small transportable station which could be utilized virtually at any spot on earth within the electronic visibility of Syncom's coverage, including the United States. A 10-foot reflector antenna system was constructed and successfully demonstrated its terminal capabilities. TAB

N66-34859*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MECHANICAL AND PHYSICAL PROPERTIES OF THE ECHO II METAL-POLYMER LAMINATE
C. L. Staugaitis and L. Kobren Washington, NASA, Aug. 1966 36 p refs
(NASA-TN-D-3409) CFSTI: HC $2.00/MF $0.50 CSCL 11D

Results of a comprehensive investigation of the physical and mechanical properties of the Echo II material are reported.

The Echo II material (an aluminum–mylar–aluminum composite film) was subjected to a variety of tests and environmental controls designed to evaluate its properties under anticipated service conditions. This test program included the determination of creep and relaxation properties, peel strength, electrical conductivity, and uniaxial and biaxial stress properties.. Additional tests were performed on material which had been exposed to electron radiation of various energies and total exposures. In addition to laboratory tests on small samples of the composite film, biaxial strain data were obtained from a full size balloon used in a Static Inflation Test. Test results including a failure analysis performed on several full scale balloons which failed prematurely are also reported. Author

N66-35171*# Perkin-Elmer Corp., Norwalk, Conn. Electro-Optical Div.

LASER COMMUNICATION SATELLITE EXPERIMENT (LCSE)

Herbert F. Wischnia 1 Jul. 1966 176 p *refs Its* Rept.-8399 (Contract NAS8-20115)

(NASA-CR-77462) CFSTI: HC $5.00/MF $1.25 CSCL 20E

Equipment for the Laser Communication Satellite Experiment (LCSE), and experimental procedures for the experiment are described. Also described are the functions of the LCSE laser/telescope; Apollo Spacecraft modifications for the LCSE; and technical requirements and parameters for components of the LCSE. Calculations of the expected power requirements for the space-to-earth communication link are presented. Information is also given for Ground Station PCM/PL receiver and tracker; and types of data to be developed from the experiment are discussed. The pre-flight, in-flight, and post-flight time requirements allotted the astronauts are outlined, along with a cost and schedule summary. Data tables and curves, and illustrative diagrams relating to the LCSE are included. L.S.

N66-35195# Radio and Space Research Station, Slough (England).

OPTICAL OBSERVATIONS OF SATELLITES RECEIVED BY THE SATELLITE ORBITS GROUP FOR THE MONTH OF MARCH 1966 AND SUPPLEMENTARY OBSERVATIONS *FOR THE MONTHS OF JUNE 1962 AND FEBRUARY 1966*

[1966] 49 p

CFSTI: HC $2.00/MF $0.50

Observational data of satellites and rockets are presented in tabular form. The data includes station, U.T. time, right ascension, declination, and magnitude. N.E.N.

N66-35656*# National Aeronautics and Space Administration, Washington, D. C.

COMMUNICATIONS SATELLITES

Washington, GPO [1966] 22 p

(EP-40) CFSTI: HC $1.00/MF $0.50 CSCL 22B

Historical background, purpose, and problems and their solutions are briefly presented. The function of active and passive satellites is outlined, and characteristics are given of Echo and II, Telstar, Relay, and Project Syncom. The role of satellites in television transmission and in commercial application is discussed. Technical questions are considered, and future technical developments in general, and the ATS Project in specific, are covered. K.W.

N66-36329*# National Aeronautics and Space Administration, Washington, D. C.

STABILIZATION REQUIREMENTS FOR COMMUNICATION AND NAVIGATION SATELLITES

A. M. Greg Andrus *In its* Symp. on Passive Gravity-Gradient Stabilization 1966 p 19–32 (See N66-36326 21-31) GPO: HC $1.75; CFSTI: MF $1.75

The need for communications satellites developed as a result of increasing world requirements for long-distance real-time communications. The paper summarizes the evolution of long-distance communications, including submarine cables, Moon-bounce techniques, and Courier, Score, Echo I and II, Relay, Telstar, and Syncom satellites, and discusses, in particular, the gravity-gradient efforts that the NASA Communication and Navigation Programs Division is pursuing as part of the Applications Technology Satellite (ATS) flight project. Some applications of active and passive stabilization systems to future mission possibilities, such as direct voice and television broadcast, navigation traffic control, and orbiting relay satellites for deep-space communications and navigation, are discussed. Author

N66-36330*# Goodyear Aerospace Corp., Akron, Ohio.

RICE/WILBERFORCE GRAVITY-GRADIENT DAMPING SYSTEM

A. C. Buxton, D. E. Cambell, and K. Losch *In* NASA, Washington Symp. on Passive Gravity-Gradient Stabilization 1966 p 35–54 refs (See N66-36326 21-31) GPO: HC $1.75; CFSTI: MF $1.75

The concept and performance of the Rice/Wilberforce (R/W) gravity-gradient damper as applied to the NASA Langley Research Center lenticular communication satellite are discussed. This damper is somewhat similar to the lossy hysteresis spring damper but has a very essential difference. The R/W damper is a viscous-fluid or other equivalent rate-sensitive damper which exploits resonant rises and cross coupling in a helical spring between the plunging and torsional modes. It achieves thereby a high articulation gain which converts the low angular rates of gravity-gradient librations into relatively high angular rates of rotation in the viscous damper. The viscous drag coefficient, spring constants, masses, and inertias of the damper are selected and tuned to dissipate maximum energy at discrete satellite libration frequencies, such as the fundamental or second harmonic in pitch and roll. Thus, the usual limitation in the performance of rate-sensitive damping devices in gravity-gradient systems is removed. Damping about all three axes of satellite motion is provided. Author

N66-36334*# TRW Systems, Redondo Beach, Calif.

TWO-DAMPER PASSIVE GRAVITY-GRADIENT STABILIZATION SYSTEM

A. E. Sabroff *In* NASA, Washington Symp. on Passive Gravity-Gradient Stabilization 1966 p 115–132 refs (See N66-36326 21–31) GPO: HC $1.75; CFSTI: MF $1.75

A design study of a symmetrical, vertistat, passive gavity-gradient stabilization system suitable for communication satellite application is presented. The design employs two damping bodies connected to the main satellite structure through magnetic hysteresis dampers. The suspension point of the three bodies in their nominal common center of mass. Each damping body possesses a single degree of angular freedom relative to the main satellite and the damping body motions lie in orthogonal planes. The gradient optimization study utilized to select this design from classes of boom-damper systems is described. Preliminary parametric tradeoff studies are presented to establish the relationships between ultimate pointing accuracy and both small-angle and large-angle transient responses. Analytic modeling of the hysteresis damper is presented and the orbital disturbance model, including thermal bending of the extendible rods, is developed. The generalized

digital simulation utilized for system evaluation is described. Both ultimate pointing accuracy and transient response from initial tumbling are evaluated, the latter in the presence of angular position limits on the allowable relative motion between a damping body and the main satellite structure. Author

N66-36507# Collins Radio Co., Dallas, Tex.
COMMUNICATIONS SYSTEMS UTILIZING PASSIVE SATELLITES
Robert T. Hart *In* Canaveral Council of Tech. Soc. 3d Space Congr. 1966 p 1–20 refs (See N66-36506 22-30)

The history of the passive satellite communications experiments to date and solutions to the deficiencies that have been indicated are presented. The solutions include a preview of studies of new materials and satellite configurations. Communications system capability utilizing the proposed satellites is detailed for conventional and specialized networks. Author

N66-37267*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE EARTH'S LONGITUDE GRAVITY FIELD AS SENSED BY THE DRIFT OF THREE SYNCHRONOUS SATELLITES
C. A. Wagner Washington, NASA, Oct. 1966 111 p refs (NASA-TN-D-3557) CFSTI: HC $3.00/MF $0.75 CSCL 08N

One hundred and fifty-two orbits of three syncronous communications satellites have been analyzed for sensitivity to earth longitude gravity components through third order which are in resonance with them. Eighty-seven orbits are of Syncom 2 with inclination between 32° and 33° and distributed (but not uniformly) in mean geographic longitude between 66° and 305°. Nineteen orbits, distributed with fair uniformity between 173° and 180°, are of the nearly geostationary Syncom 3. Forty-six orbits are of the nearly geostationary Early Bird satellite between 330° and 332° longitude. These orbits were calculated without consideration of resonant gravitational effects. The orbit data was reduced to give a set of essentially nine well determined long term longitude accelerations for these satellites between 66° and 332°. From this reduced acceleration record, after extensive testing, four earth longitude gravity harmonics of second and third order appear to be well discriminated. These harmonics with their standard errors, for which adjustments for sun and moon effects and the probable influence of neglected higher order earth gravity have been made, are: $J_{22}=-(1.816 \pm 0.020)\times 10^{-6}$ (This corresponds to a difference in major and minor axes of the earth's elliptical equator of 69.4 ±0.8 meters), $\lambda_{22}=-(15.4 \pm 0.3)°$, $J_{33}=-(0.171\pm 0.017)\times 10^{-6}$, and $\lambda_3=(24.9\pm 3.3)°$. In addition to these harmonics, a third pair (J_{31}, λ_{31}) was poorly discriminated from the limited acceleration record. Author

N66-37353*# Institut Geographique National, Hann-Dakar (Senegal).
GEODETIC JUNCTION OF FRANCE AND NORTH AFRICA BY SYNCHRONIZED PHOTOGRAPHS TAKEN FROM ECHO I SATELLITE
H. M. Dufour *In* NASA, Washington Satellite Geodesy, 1958–1964 1966 p 109–120 (See N66-37346 22-13) GPO: HC $0.70; CFSTI: MF $1.25

The principles of triangulation by satellite are reviewed briefly, the instruments needed are described, and the field operations are discussed. The results obtained are assessed and methods for increasing the precision of the measurements are listed. H.S.W.

N66-37914# Technical Univ. of Warsaw (Poland).
ADJUSTMENT OF STELLAR TRIANGULATION AND ANALYSIS OF RESULTS
Weneda Dobaczewska and Wlodzimierz Baran (Coll. of Agr., Olsztyn, Poland) *In* Polish Acad. of Sci. Artificial Satellites Mar. 1966 p 58–70 refs Prepared jointly with Coll. of Agr., Olsztyn, Poland (See N66-37906 23-07) CFSTI: HC $5.00/MF $1.00

On the basis of results of synchronous observations of the Echo I satellite from several stations, equations are derived for adjusting satellite triangulation using the method of least squares. S.C.W.

N66-37915# Polish Academy of Sciences. Warsaw. Computing Center.
RESULTS OF APPLYING THE TETRAHEDRON METHOD FOR SYNCHRONOUS OBSERVATIONS OF ECHO I MADE DURING MAY AND JUNE 1963
Wojciech Pachelski and Janusz Zielinski (Tech. Univ. of Warsaw) *In its* Artificial Satellites Mar. 1966 p 70–75 refs Prepared jointly with Tech. Univ. of Warsaw (See N66-37906 23-07) CFSTI: HC $5.00/MF $1.00

The tetrahedron method is defined as a means of determining the vector coordinates connecting two observing stations, based on two pairs of synchronous satellite observations and the distance between the two observed satellite positions. The concept is derived from the geometric body formed by four directions to the satellite, the line connecting the observing stations, and the chord of the orbit. Formulas for computing chord length are derived for reducing mean elements to the observation moments; the true eccentric anomaly and the latitude argument; perturbation corrections, with the effect of earth oblateness considered; and satellite coordinates. On the basis of published data on the experimental network of satellite triangulation, tetrahedrons were generated for three pairs of stations. Tabulated data are presented on the observations and computed lengths of orbit chords; mean values of coordinates and vector lengths found by solving each of the tetrahedrons; and their mean errors, and mean errors of individual observations. For comparison, coordinates and vector lengths calculated from geodetic coordinates are given. Results confirm the accuracy of the method. S.C.W.

N66-37916# Academia R. P. R., Bucharest. Observatorul Astronomic.
SOME CONSIDERATIONS CONCERNING ERROR INFLUENCE ON THE "INTEROBS" PROGRAM [QUELQUES CONSIDERATIONS SUR L'INFLUENCE DES ERREURS DANS LE PROGRAMME "INTEROBS"]
Alexandru Dinescu *In* Polish Acad. of Sci. Artificial Satellites Mar. 1966 p 76–79 refs In FRENCH (See N66-37906 23-07) CFSTI: HC $5.00/MF $1.00

Investigated are satellite position errors, and the manner in which errors are propagated. Methods of calculating a satellite's orbit are reviewed, such as cosmic triangulation through reduction of Echo I photographic observations. Tabular data are presented for geocentric vectors, topocentric vector errors due to initial errors of observation stations, and errors due to satellite topocentric position calculations. Emphasis is placed on the influence of initial observation errors and their influence in the INTEROBS program. Transl. by R.LI.

N66-37976*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ADVANCED RESEARCH FOR COMMUNICATIONS SATELLITES

Robert J. Mackey, Jr. *In its* Publ. of Goddard Space Flight Center, 1964 Vol. II: Space Technol. [1965] p 20–21 Submitted for Publication (See N66-37974 23-31) GPO: HC $7.75; CFSTI: MF $5.75

An overview is presented of investigations related to ground systems, propagation paths, active communication satellites, microwave conversion, and spacecraft antennas, and mention is made of current projects and future plans in each of these areas. It is noted that to date all of the communications satellites have radio frequencies below 10,000 mc, and that overcrowding in the present frequency bands points to the desirability of moving to higher frequencies. Mention is made of efforts to directly convert from one microwave frequency to another without resorting to an intermediate frequency; one method under investigation employs a "serrodyne" technique, while the other uses a re-entrant traveling wave tube. A study of electronic beam shaping and steering techniques was initiated; and improved lightweight structural materials, plastic removal, and erection techniques are being investigated. M.W.R.

N66-37977*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ORBITAL PLACEMENT AND CONTROL OF THE SYNCOM II SPACECRAFT

James L. Baker *In its* Publ. of Goddard Space Flight Center, 1964. Vol. II: Space Technol. [1965] p 163–184 refs Presented at the 15th Intern. Astron. Congr., Warsaw, Sep. 1964 (See N66-37974 23-31) GPO: HC $7.75; CFSTI: MF $5.75

Details are presented on the performance of various control system elements, and the principles and sequence of operation are described for the SYNCOM II orbit placement and control. Determination of SYNCOM orbits was facilitated by the use of a range and range rate system, a two-way coherent communication technique using the existing communications ground station power amplifier, antenna, ancillary ground equipment, and the spacecraft frequency translation communications transponder. It is concluded that the apogee motor, apogee motor ignition timer, sun sensors, and hydrogen peroxide unit for SYNCOM II performed well; problems with leakage and low specific impulse in the nitrogen unit made it unattractive for primary orbit control of the spacecraft. Mass transfer effects due to duel caused major changes in the spin rate; and the spin rate will decay at the rate of about 0.1 rpm per month, due to magnetic damping, because the nitrogen is expended and the HOH is nearly depleted. The range and range rate system performed better than expected; range rate measurements were 0.02 m/sec as compared with the design goal of 0.05 m/sec. M.W.R.

N66-39663# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SYNCHRONOUS OBSERVATIONS OF ECHO 1 IN 1963

D. Ye. Shchegolev 23 Feb. 1966 5 p ref Transl. into ENGLISH from Astron. Sov. Byul. Stantsiy Optich. Nablyudeniya Iskusstv. Sputnikov Zemli (USSR), no. 36, 1965 p 21–22 (FTD-TT-65-1736; TT-66-62097; AD-637419) CFSTI: HC $1.00/MF $0.50

Photographic observations of the artificial earth satellite were made from the tracking stations of the German Democratic Republic, Poland, Rumania, the Soviet Union and Czechoslovakia. Information from all stations allowed the selection of synchronous groups from the number of obtained negatives. TAB

N66-39899*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE RELAY I RADIATION EFFECTS EXPERIMENT

Ramond C. Waddel Washington, NASA, Nov. 1966 23 p refs Previously Published in NASA SP-76; N66-10226 01-31 (NASA-TN-D-3665; NASA-SP-76) CFSTI: HC $1.00/MF $0.50 CSCL 04A

Solar cells on Relay I were monitored for radiation damage by measurement of short circuit current. The orbit was 1321 km perigee, 7439 km apogee, 47.5 degrees inclination. Unshielded N/P, P/N, and gallium arsenide cells degraded in 10 days to 52, 28, and 18 percent, respectively. This damage is ascribed to low energy protons. At 300 days, silicon N/P and P/N cells, shielded with 30 mils of fused silica, had degraded to 73 and 53 percent respectively. At 300 days, silicon N/P and P/N cells, shielded with 60 mils of fused silica, had degraded to 80 and 61 percent, respectively. Available space flux maps predicted somewhat greater damage to the heavily shielded cells, from either electrons or high energy protons, than that observed. The minority carrier lifetime of some 1N645 silicon diodes declined to 50 percent in about 45 days. Author

1967
STAR ENTRIES

N67-10187*# National Aeronautics and Space Administration, Washington, D. C.

REPORT ON THE OBSERVATIONS MADE BY THE PLEUMEUR-BODOU SPACE TELECOMMUNICATION STATION ON THE VARIOUS ORBITAL-POSITIONING PHASES OF SYNCOM II

R. Sueur 21 Aug. 1963 3 p Transl. into ENGLISH of the French Report, 14 Aug. 1963 (NASA-TT-F-8522) CFSTI: HC $1.00/MF $0.50 CSCL 09F

To determine the locus on the earth's surface of the satellite position, observations on the various orbital-positioning phases of Syncom II were made with a control tracker. The azimuth and elevation of the satellite at every instant was recorded. The accuracy of azimuthal information was found to be approximately one degree; that of the elevation information, about one degree for elevations higher than 20° R.LI.

N67-10193*# National Aeronautics and Space Administration, Washington, D. C.

VISUAL SATELLITE OBSERVATIONS CONDUCTED BY THE STADE TRACKING STATION

Horst Köhnke Apr. 1965 5 p Transl. into ENGLISH of the book "Visuelle Satellitenbeobachtungen Durchgeführt von der Satellitenstation Stade" West Germany (NASA-TT-F-9320) CFSTI: HC $1.00/MF $0.50 CSCL 22C

COSPAR Station No. 2567 reports tracking observations of the following satellites: Echo I, Echo II, Cosmos 44, Cosmos 53, Cosmos 59, Kappa 1, Midas IV, and Voskhod 2. Some new satellites observed are also listed. R.LI.

N67-10233*# National Aeronautics and Space Administration, Washington, D. C.

VISUAL SATELLITE OBSERVATIONS FROM SATELLITE STATION STADE [VISUELLE SATELLITENBEOBACHTUNGEN DURCHGEFUEHRT DER SATELLITENSTATION STADE]

Horst Kohnke Apr. 1965 5 p Transl. into ENGLISH from GERMAN
(NASA-TT-F-9314) CFSTI: HC $1.00/MF $0.50 CSCL 22A

Charted data obtained from these observations are presented. The data includes the date of the observation, the revolution number, the object observed and its code name, the time of the observation, the magnitude, and the light change tumbling period. H.S.W.

N67-10755*# National Aeronautics and Space Administration, Washington, D. C.
SATELLITE OBSERVATIONS MADE AT SATELLITE STATION STADE
Horst Kohnke [1966] 2 p Transl. into ENGLISH from German
(NASA-TT-F-9311) CFSTI: HC $1.00/MF $0.50 CSCL 22C

The time, magnitude, and variation in brightness are tabulated for the satellites observed from March 2 to March 7, 1965. N.E.N.

N67-10881*# RAND Corp., Santa Monica, Calif.
MULTIPLE-ACCESS TECHNIQUES FOR COMMUNICATION SATELLITES: DIGITAL MODULATION, TIME-DIVISION MULTIPLEXING, AND RELATED SIGNAL PROCESSING
C. R. Lindholm Sep. 1966 98 p refs
(Contract NASr-21(02))
(NASA-CR-79748; RM-4997-NASA) CFSTI: HC $3.00/MF $0.75 CSCL 17B

Background theory and data are presented as an aid for designing and evaluating digital and time-division approaches to the communication satellite multiple access problem. Spceific features of digital techniques are examined, with emphasis placed on time-division multiplexing, error correction codes, analog-to-digital conversion methods, and synchronization. Amplitude and frequency modulation, and phase shift keying are discussed from the viewpoint of performance parameters. System difficulties which may be encountered in time-division multiplexing are enumerated. Also considered are the pulse code and delta modulation techniques used in analog-to-digital and digital-to-analog conversion, along with the performance parameters characterizing system error rate or signal-to-noise ratio. Tables and graphs are included to show the relations needed in evaluating system performance. M.G.J.

N67-10884*# RAND Corp., Santa Monica, Calif.
A CLASS OF CODES FOR MULTIPLE-ACCESS SATELLITE COMMUNICATION SYSTEMS
P. M. Spira Sep. 1966 30 p refs
(Contract NASr-21(02))
(NASA-CR-79745; RM-5131-NASA) CFSTI: HC $2.00/MF $0.50 CSCL 09D

A mathematical method is described for allocating time and frequency in communication satellite systems that use time–frequency multiplexing for random multiple access. Algorithms are given for constructing low interference address codes for various sizes of time–frequency matrixes and address lengths. As many addresses as possible are constructed so that no two of them have more than one chip in common. At the same time, for a fixed address length, the number of addresses containing a given chip can be made arbitrarily large and will be almost exactly proportional to the number of chips in the time–frequency matrix. Minimal interference is obtained by demanding that any two addresses have at most one common chip, and by the symmetry of the construction to facilitate analysis of system performance. It was also found possible to satisfy continuous transmission requirements without losing the ability to accommodate large numbers of users. M.G.J.

N67-11361*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON THE LONG-PERIOD MOTION IN THE SEMI-MAJOR AXIS OF THE ORBIT OF THE TELSTAR 2 SATELLITE
James P. Murphy Jun. 1966 17 p refs
(NASA-TM-X-55579; X-547-66-260) CFSTI: HC $1.00/MF $0.50 CSCL 22C

A representation for the indirect effect of solar radiation pressure on the semi-major axis of an artificial earth satellite caused by passage in and out of the earth's shadow is examined. The theory is then used to explain the appearance of periodicities in the observed semi-major axis of the orbit of Telstar 2. Author

N67-11914# Radio and Space Research Station, Slough (England).
KINETHEODOLITE OBSERVATIONS OF SATELLITES RECEIVED BY THE SATELLITE ORBITS GROUP FROM MALTA FOR JUNE 1966
1966 39 p *Its* Issue No. 18
CFSTI: HC $2.00/MF $0.50

Tables detail kinetheodolite observations received from the Malta tracking station on the time, azimuth, and elevation of various United States and Russian satellites and Rockets in orbit during the period from June 1 through June 22, 1966. Satellites and rockets that were launched between 1960 and 1965 are included, and refraction corrections have been applied to the observations. M.W.R.

N67-11915# Radio and Space Research Station, Slough (England).
KINETHEODOLITE OBSERVATIONS OF SATELLITES RECEIVED BY THE SATELLITE ORBITS GROUP FROM MALTA FOR JUNE AND JULY 1966
1966 61 p *Its* Issue No. 19 For Abstract See N67-11914 02-07
CFSTI: HC $3.00/MF $0.75

N67-12003# Joint Publications Research Service, Washington, D. C.
USE OF ARTIFICIAL EARTH SATELLITES FOR GEODESY
A. P. Polezhayev 8 Nov. 1966 33 p Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Geod. i Aerofotos. (Moscow), no. 2, 1966 p 27–48
(JPRS-38537; TT-66-34962) CFSTI: $2.00

Discussed is the use of non-geodetic and geodetic earth satellites for solving geometrical problems associated with determining absolute or relative positions of points on the earth's surface and dynamic problems associated with determining the dimensions and form of the earth. Included is a review of several geodetic satellites which are being developed abroad. S.C.W.

N67-12150*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
SATELLITE ORBITAL DATA NO. E-5
Beatrice Miller 30 Sep. 1966 39 p
(Grant NsG-87-60)
(NASA-CR-80092; SAO Special Rept.-222) CFSTI: HC $2.00/MF $0.50 CSCL 22C

Tabulated data are presented on the orbital mean elements derived from satellite observations covering several days. These include the Vanguard 2 and 3, the Echo 1, Explorer 9, Transit 4A, Injun 3, Midas 4, Telstar 1, and the A15 Relay; the time period extends from January to June 1963. The data obtained involved use of lunisolar perturbations and tesseral harmonics. S.P.

N67-12207*# Goodyear Aerospace Corp., Akron, Ohio.
AN INDICATED SPECULAR DEGRADATION RATE FOR ALUMINIZED MYLAR SURFACES IN NEAR-EARTH ORBIT FROM RECENT PHOTOMETRIC OBSERVATIONS OF THE ECHO I SATELLITE
Richard H. Emmons 17 Jun. 1964 16 p refs Presented at the 116th Meeting of the Am. Astron. Soc., Flagstaff, Ariz., 24–27 Jun. 1964
(Contract NAS1-3114)
(NASA-CR-80175; GER-11521, rev. A) CFSTI: HC $1.00/MF $0.50 CSCL 22A

Photometric measurements were made of the Echo I satellite with a visual comparison photometer on 1 March 1964. The data, taken over a wide range of phase angles (143 to 32 deg) and normalized for slant range, are best fitted in illuminance versus Russell's phase function by a surface model that is 96 percent specular and 4 percent diffuse. This indicates that the actual specular degradation rate for aluminized Mylar surfaces in a near-earth orbit, due to the combined effects of all environmental factors, is less than 1 percent per year. Together with the results from laboratory hypervelocity impact tests of very small particles on aluminized Mylar, the present indications may prove of value in further defining the micrometeoroid environment at Echo I's orbital height, either with respect to the flux in the vicinity of the mass cutoff or the mass cutoff itself. The present indications should also prove of value in predicting the useful life in nearby space of exposed optical and thermal balance surfaces. Author

N67-12301*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
TELSTAR I, VOLUME 4
Dec. 1965 448 p refs
(NASA-SP-32, Vol. 4) CFSTI: HC$7.48/MF$2.00 CSCL 17B

Papers on operation, characteristics, and performance of communications satellite tracking facilities are presented. For individual titles see N67-12302–N67-12320.

N67-12302*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
FUCINO EARTH STATION OPERATION ANALYSIS
In its Telstar I, Vol. 4 Dec. 1965 p 1941–1947 (See N67-12301 03-07) CFSTI: HC$7.48/MF$2.00

A description and operational analysis of the Fucino communications station is presented. This station is located close to Rome, Italy; it encompasses a 30 ft. steerable dish antenna for monopulse beacon tracking and communications receiving and also video band and test equipment. A wideband reception test via Telstar was successfully conducted at the station. The employed monopulse tracking system yielded good results and proved satisfactory. G.G.

N67-12303*# Centre National d'Etudes des Telecommunications, Issy-les-Molineaux (France).
DESCRIPTION OF THE INSTALLATIONS AT THE PLEUMEUR-BODOU SPACE COMMUNICATIONS STATION
M. J. Dautrey *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 1951–1998 (See N67-12301 03-07) CFSTI: HC$7.48/MF$2.00

The Pleumeur-Bodou, France, telecommunications station is equipped to study all problems connected with active satellites by link performance, acquisition, tracking, telemetry, and command. It constitutes the basic facility for experimental studies of space communication systems in France. Detailed descriptions of the station's site, overall design, buildings, and operational requirements are given with emphasis on the command tracker, the terminal equipment, the simulator equipment of its boresite tower, and its power supply system. G.G.

N67-12304*# Centre National d'Etudes des Telecommunications, Issy-les-Molineaux (France).
RESULTS OF TESTS PERFORMED WITH THE TELSTAR SATELLITE AT THE PLEUMEUR–BODOU SATELLITE COMMUNICATION STATION
L. Bourgeat, A. Dyeure, and J. P. Houssin *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 1999–2055 (See N67-12301 03-07) CFSTI: HC$7.48/MF$2.00

Active satellite communications tests at this French ground station were analyzed to establish the feasibility of satellite acquisition and tracking by a very narrow beamwidth antenna. System tests of telephone channels and television links via satellite confirmed the possibility of a wideband communications link between continents by the use of satellites. A solution for the problem of pointing the directive antenna accurately in the direction of a satellite at the moment it appears and then keeping it pointed at the moving satellite was found. G.G.

N67-12305*# Post Office Engineering Dept., London (England).
THE POST OFFICE COMMUNICATION SYSTEM GROUND STATION AT GOONHILLY, CORNWALL
W. J. Bray and F. J. D. Taylor *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2059–2076 Reprinted (See N67-12301 03-07) CFSTI: HC$7.48/MF$2.00

The post office satellite communication system ground station in Cornwall, England, is particularly suitable for transatlantic communications. It employs an 85-ft diameter stearable paraboloidal-reflector dish aerial; transmitters; low noise receiving equipment; terminal equipment for transmission and reception of multi-channel telephone; telegraph and television signals; video; multi-channel telephone telegraph links to the trunk network; and support communications for the transmission of data and other information via projects Relay and Telstar. G.G.

N67-12306*# Post Office Engineering Dept., London (England).
THE GOONHILLY 85-ft. STEERABLE DISH AERIAL
C. N. Kington (Husband and Co.) and H. E. Pearson *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2077–2089 Reprinted in Cooperation with Husband and Co. (See N67-12301 03-07) CFSTI: HC$7.48/MF$2.00

Design, manufacture, construction, and testing of an 85-feet steerable dish aerial for a satellite communication ground station is discussed. A fully transistorized digital control system is used to drive the system automatically from a control desk. Successive tracking observations of the star Alpha Ursa Major produced smooth azimuth and elevation angles against time as the star moved across the sky and thus proved that the aerial pointed correctly. Measurements on incoming radio signal strength from a 4000 Mc/s transmission source about 21 miles distant, established the measured beamwidth at 13 minutes as compared with the theoretical value of 12 minutes. G.G.

N67-12307*# Post Office Engineering Dept., London (England).
COMPUTING AND DATA TRANSMISSION FOR THE PREDICTION STEERING OF THE GOONHILLY SATTELITE-COMMUNICATION AERIAL
E. C. Seaman and W. E. Thompson *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2091–2099 Submitted for Publication (See N67-12301 03-07) CFSTI: HC $7.48/MF$2.00

Orbital prediction computations were converted into continuous real-time azimuth and elevation pointing instructions for a satellite tracking ground station aerial. Satellite position predictions were expressed by a rectangular coordinate system with axes in the directions East, North, and vertical and the origin at the center of the aerial's motion. Predictions in this form were transmitted

over transoceanic telegraph circuit for a receiving teleprinter that produced simultaneously a page print and a perforated tape. Transmission time was about six seconds for each minute of satellite pass. G.G.

N67-12309*# Post Office Engineering Dept., London (England).
BEAM-SWINGING FACILITIES FOR THE GOONHILLY SATELLITE-COMMUNICATION AERIAL
C. F. Davidson and W. A. Rawlinson *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2117–2126 Reprinted (See N67-12301 03-07) CFSTI: HC $7.48/MF $2.00

The general arrangement of the beam-swinging mechanism to steer a tracking aerial by means of predicted data computations encorporates motions about gimbals controlled by hydraulic pistons mounted orthogonally in the main frame, and around those placed midway on the feed support tube for a conical scan motion. The conical scan motion is applied at the onset of the satellite pass. If the radial display reveals any offset of the satellite trajectory from the aerial beam, a hand control is used to steer the beam exactly on the course of the satellite. If the divergence of the beam from the boresight axis of the aerial is more than about 4 ft., then azimuth and/or elevation corrections to the predicted course of the aerial are performed by the aerial controller. G.G.

N67-12310*# Post Office Engineering Dept., London (England).
A 4/6 Gc/s CIRCULARLY-POLARIZED DIPLEXER FOR THE GOONHILLY SATELLITE-COMMUNICATION AERIAL
D. Chakraborty and G. F. D. Millward Submitted for Publication (See N67-12301 03-07)

A diplexer is described that transmits some 4 to 5 kilowatts of microwave power and simultaneously receives a micro–microwatt signal from a communications satellite when used in conjunction with an earth station aerial. The diplexer works together with a broadband reciprocal polarizer since the transmitted signal in the dish aerial polarizes left handed and the received signal emits polarized righthanded. This diplexer and broadband polarizer system were successfullly used for tests with Telstar satellite transmissions. G.G.

N67-12312*# Post Office Engineering Dept., London (England).
WAVEGUIDE FEEDER SYSTEM FOR THE GOONHILLY SATELLITE-COMMUNICATION EARTH STATION
I. F. Mac Diarmid and S. C. Gordon *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2157–2166 Submitted for Publication (See N67-12301 03-07) CFSTI: HC $7.48/MF $2.00

Special features of the waveguide installation on the aerial are outlined and performance data are given. Three separate waveguide connections between the turntable cabin and the focus platform are required to rotate the joints on the elevation axis of the aerial; one each for the Telstar and Relay transmitters operating at 6390 and 1725 Mc/s, respectively, and one for the receiver feed routed via maser cabin on the back of the dish antenna and operating at 4170 and 4080 Mc/s. A dominant-mode rectangular waveguide is used for these runs. G.G.

N67-12315*# Post Office Engineering Dept., London (England).
A LOW-TEMPERATURE THERMAL NOISE SOURCE FOR USE AT THE GOONHILLY SATELLITE-COMMUNICATION EARTH STATION
H. N. Daglish *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2195–2199 Submitted for Publication (See N67-12301 03-07) CFSTI: HC $7.48/MF $2.00

A matched waveguide termination was required as part of the noise temperature calibration facility in the receiving system at the Goonhilly earth-station. For routine measurement of overall system noise temperature, this termination is at ambient temperature. For other noise measurements, and in particular for the measurement of the effective input noise temperature of the maser, the waveguide termination is cooled to 77°K by immersion in liquid nitrogen. Author

N67-12316*# Post Office Engineering Dept., London (England).
DEMODULATION TECHNIQUES FOR USE AT GOONHILLY SATELLITE-COMMUNICATION EARTH STATION
R. W. White and R. J. Westcott *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2201–2210 refs Submitted for Publication (See N67-12301 03-07) CFSTI: HC $7.48/MF $2.00

The following three types of demodulators were evaluated to determine optimum demodulation techniques for communication satellite systems: (1) a conventional demodulator; (2) a frequency modulation feedback demodulator in which the signal deviation is reduced before it reaches the final discriminator; and (3) a variable bandwidth dynamic-tracking demodulator in which the resonant frequency of a narrow bandwidth tuned circuit moves rapidly to follow the nominal instantaneous frequency of the incoming signal. It was concluded that for a carrier/noise ratio greater than that corresponding to threshold conditions, a conventional demodulator is preferred; specialized demodulators can be efficient at carrier/noise ratios less than 10 db; and at carrier/noise ratios less than 6 db show a marked preference for specialized demodulators. G.G.

N67-12317*# Services Electronics Research Lab., Baldock (England).
A HIGH POWER TRAVELLING WAVE TUBE FOR SATELLITE COMMUNICATIONS
M. O. Bryant, A. Thomas, and P. W. Wells *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2211–2217 refs Submitted for Publication (See N67-12301 303-07) CFSTI: HC $7.48/MF $2.00

This paper describes the CW travelling wave tube used by the General Post Office in their ground transmitter for Project Telstar. It operates in the 6000 Mc/s band with a maximum power output of about 5 kw and a bandwidth of greater than 100 Mc/s. The factors influencing the design of the valve and its performance are discussed in some detail. Author

N67-12318*# Associated Electrical Industries, Ltd., Manchester (England).
THE OUTPUT STAGE FOR THE GROUND TRANSMITTER AT GOONHILLY
A. R. Petherham *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2219–2227 ref Submitted for Publication (See N67-12301 03-07) CFSTI: HC $7.48/MF $2.00

A traveling wave tube with a bandwidth of about 100 Mc/s is used as power output amplifier for a ground transmitter. The electron beam in the tube passes first through a hole in the anode and then through the center of a cloverleaf slow wave structure before striking the collector. Amplification takes place due to the interaction between the beam and the fields associated with the waveguide structure. This amplifier is located in a cabin placed on a turntable underneath the ground station's aerial. G.G.

N67-12319*# Post Office Engineering Dept., London (England).
RESULTS OF TESTS AT GOONHILLY USING THE EXPERIMENTAL COMMUNICATION SATELLITES TELSTAR I AND TELSTAR II

W. J. Bray, F. J. D. Taylor, and R. W. White *In* NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2229–2260 (See N67-12301 03-07) CFSTI: HC $7.48/MF $2.00

Results from tests and demonstrations with the Telstar satellites were surveyed and examined. Evaluation of television transmission, multiple channel telephony and telegraphy, and facsimile and data transmission showed that active communication satellites can provide high quality stable circuits; especially good transmissions were obtained for color television signals. The tracking of satellites to within 10 minutes of arc, from orbital data predicted up to a fortnight in advance, is established. G.G.

N67-12320*# Bell Telephone Labs., Inc., New York.
COMMUNICATIONS AND RADIATION EXPERIMENTS WITH TELSTAR II

In NASA. Goddard Space Flight Center Telstar I, Vol. 4 Dec. 1965 p 2263–2373 refs (See N67-12301 03-07) CFSTI: HC $7.48/MF $2.00

Test results made on Telstar II shortly after launch in May, 1963, and again during March and April, 1964, did not establish any unpredicted performance changes during the eleven months. Comparison of radiation damage between Telstar I and Telstar II found deterioriation of the small solar power plant and the measuring sensor transistors in Telstar II due to the presence of very large fluxes of low energy protons. Electron measurements made in a higher energy range on Telstar II showed the characteristics of the inner and outer Van Allen belt structure. G.G.

N67-13020*# Environmental Science Services Administration, Boulder, Colo.
IDEALIZED ANTENNA PATTERNS FOR USE IN COMMUNICATION-SATELLITE INTERFERENCE STUDIES

P. L. Rice, W. I. Thompson, III, and J. L. Noble [1966] 14 p refs
(NASA Order R-68)
(NASA-CR-79405) CFSTI: HC $1.00/MF $0.50 CSCL 17B

Antenna patterns to represent earth station antennas of communication satellite systems are derived from available published data. The patterns include an analytic expression describing the main beam and first side lobe. Higher order side lobes are specified in terms of smoothed mean power levels of these side lobes. Author

N67-13960# Royal Aircraft Establishment, Farnborough (England).
THE LARGE SEMI-ANNUAL VARIATION IN EXOSPHERIC DENSITY: A POSSIBLE EXPLANATION

G. E. Cook Jul. 1966 12 p refs
(RAE-TR-66211) CFSTI: HC $1.00/MF $0.50

Analysis of the orbit of the satellite Calsphere 1 confirms the large semiannual variation in density at heights near 1100 km previously found from the orbit of Echo 2, and not predicted by present atmospheric models. This variation is probably due to relatively smaller variations at much lower altitudes; in particular variations at heights near 120 km, which is taken as the lower boundary for the construction of upper-atmosphere models. Author

N67-14273# European Space Vehicle Launcher Development Organization, Paris (France).
ACTIVE TELECOMMUNICATIONS SATELLITES [LES SATELLITES ACTIFS DE TELECOMMUNICATIONS]

M. Gilli [1966] 46 p refs In FRENCH
(ELDO-TM-F37) CFSTI: HC $2.00/MF $0.50

The principal characteristics of active telecommunications satellites launched or projected are listed. Author (ESRO)

N67-14311# Bolkon Entwicklungen K. G., Munich (West Germany).
ELDO FUTURE PROGRAM PRELIMINARY STUDY NO. 1-1 SYSTEMS STUDY ABOUT AN APOGEE-IMPULSE-SYSTEM WITH LIQUID PROPELLANTS FOR THE ELDO-A LAUNCH VEHICLE

Feb. 1964 132 p refs Work performed for ELDO
(Bolkow-RF-12e) CFSTI: HC $4.00/MF $1.00

This paper discusses the technical feasibility of increasing the payload of the ELDO-A launch vehicle to give capability of launching a communications satellite in a polar orbit from Woomera. It presents design details and development costs for 5 possible apogee impulse systems, these include a spin-stabilized liquid propellant propulsion system, a liquid propellant propulsion system with attitude control and telemetry using the electronic system and equipment of the third stage, and an entirely autonomous fourth stage. Payload studies cover an attitude range from 5000–25000 km. ESRO

N67-14455*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FACILITY CONSTRUCTION AND EQUIPMENT INSTALLATION

J. Orbison and H. L. Richter *In its* Space Programs Sum. No. 37–41, Vol. III 30 Sep. 1966 p 120–126 refs (See N67-14421 05-07) CFSTI: HC $4.25/MF $1.50

Implementation of the Mars, Pioneer, Echo, and Venus deep space stations (DSS) is described. The installation of the S-band system is reported for the Mars DSS operation, and extensive station changes are briefly reviewed for the Pioneer DSS. Installation of dc tachometers on the deep space information facility 85-ft polar antennas is described as a means of improving the interface of rate feedback signals with manned space flight network servo electronics and upgrading the rate loops of the standard tracking antennas. S.P.

N67-15027# Naval Research Lab., Washington, D. C.
ON THE DETERMINATION OF FINE SCALE IONOSPHERIC INHOMOGENEITIES BY MEANS OF A FARADAY ROTATION ANALYSIS OF ECHO II RADAR RETURNS

John M. Goodman 19 Sep. 1966 24 p refs
(NRL-MR-1723; AD-640330) CFSTI: HC $1.00/MF $0.50

Radar returns from Echo II satellite were obtained during a period of sunspot minimum at Randle Cliff (NRL-CBD). By means of a Farapay rotation analysis it was tentatively concluded that electron content inhomogeneities of a few percent exist over horizontal scales of between 8 and 24 kilometers. It was concluded that the accuracy of the technique which was employed to deduce the inhomogeneities could be improved by increasing the radar signal to noise ratio and by operating at a lower radar frequency –possibly in the HF range. Author (TAB)

N67-15220*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE FEASIBILITY OF A DIRECT RELAY OF APOLLO SPACECRAFT DATA VIA A COMMUNICATION SATELLITE

Paul E. Schmid 1 Sep. 1966 73 p refs
(NASA-TM-X-55627; X-507-66-310) CFSTI: HC $3.00 / MF $1.30 CSCL 09F

The extent to which communication satellites can be utilized in the 1970's for relaying data directly from an Apollo-type spacecraft to a fixed earth station estimated. Both 24-hour synchronous altitude (36,000 km above the earth's surface) and 6-hour orbits (10,400 km above the earth's surface) for the communication satellite are considered. A unified S-band type of data transfer is assumed. The relative merit of using frequencies below S-band for voice communication is also briefly discussed. Author

N67-15403# Air Force Cambridge Research Labs., Bedford, Mass. Terrestrial Sciences Lab.
TEST RESULTS OF A HIGH-SPEED CAPPING SHUTTER FOR LARGE-APERTURE GEODETIC CAMERAS
M. S. Tavenner and D. G. Abby Jun. 1966 36 p refs *Its* Instr. Paper no. 101
(AFCRL-66-405; AD-640589) CFSTI: HC $3.00/MF $0.65

Experiments were made with passive satellites for obtaining geodetic information using methods of stellar triangulation. Camera shutters for large-aperture cameras have presented a severe problem in timing. Using a contractor-developed capping shutter, a series of field tests was conducted with the Air Forces PC-1000 Geodetic Stellar Camera System for observations of the Echo I satellite. The report is concerned with the results of this test series and an evaluation of the capping shutter as adapted to the PC-1000 camera system. Author (TAB)

N67-16123# System Development Corp., Santa Monica, Calif.
A LOW COST COMMUNICATION SATELLITE EDUCATIONAL SYSTEM
Irving Dlugatch 15 Aug. 1966 6 p Presented at 17th Intern. Astronautical Congr., Madrid, Oct. 1966
(SP-2493; AD-640649) CFSTI: HC $3.00/MF $0.65

The report discusses the potential of satellites for education and applies the principles of system engineering to studies of system implementation and cost effectiveness. The proposed system makes use of television and of a space vehicle, and excels by the modesty of its transmitter and receiver requirements on the ground and on the spacecraft. TAB

N67-18040*# California Univ., San Deigo.
A COMPUTER ROUTINE FOR RELAY TRAPPED PROTON DISTRIBUTIONS
R. Walker Fillius 1 Sep. 1966 8 p refs
(Contract NASr-116; Grant NsG-538)
(NASA-CR-81686) CFSTI: HC $3.00/MF $0.65 CSCL 09B

The Fortran routine Relay I is described as an aid to scientists who desire easy computerized access to the trapped proton distribution measurements. The discussion covers the data reduction procedure, the coverage provided by the decks, the computation method, the call parameters, subroutines, timing, diagnostic printing, and tape assignments. A tabular summary is included on the Relay I orbit and instrumentation. M.G.J.

N67-18654*# Space-General Corp., El Monte, Calif.
STUDY OF CONCEPTUAL DEEP SPACE MONITOR COMMUNICATIONS SYSTEMS USING A SINGLE EARTH SATELLITE. VOLUME III: APPENDIX
E. F. Lally and M. Eimer Sep. 1966 316 p refs
(Contract NAS2-3179)
(NASA-CR-76036; SGC-920FR-1, Vol. III) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Condensed technological survey materials for deep space satellite communication systems are presented in this appendix to the main study. Emphasis was placed on mission analysis, satellite discipline parametric requirements, and design interface considerations for communication, power, attitude control, and environmental control. G.G.

N67-18724*# National Aeronautics and Space Administration, Washington, D. C.
SIGNIFICANT ACHIEVEMENTS IN SPACE APPLICATIONS, 1965
1966 91 p refs
(NASA-SP-137) GPO: HC $0.45; CFSTI: MF $0.65 CSCL 22A

CONTENTS:

1. SATELLITE COMMUNICATIONS AND NAVIGATION D. P. Rogers p 3–7 (See N67-18725 08-31)
2. SATELLITE GEODESY J. K. Gleim and N. G. Roman p 11–14 refs (See N67-18726 08-30)
3. SATELLITE METEOROLOGY W. C. Spreen, R. H. McQuain, and G. Tennyson, Jr. p 17–85 refs (See N67-18727 08-20)

N67-18725*# National Aeronautics and Space Administration, Washington, D. C.
SATELLITE COMMUNICATIONS AND NAVIGATION
Donald P. Rogers *In its* Significant Achievements in Space Appl., 1965 1966 p 3–7 (See N67-18724 08-31) GPO: HC $0.45; CFSTI: MF $0.65

A brief review on the various operational commercial communications satellites and their orbital performance is given with emphasis on the design of a satellite capable of being used in either a phased medium-altitude system or a synchronous system. Progress is reported in the development of various techniques for satellite communication utilizing more simplified and inexpensive ground stations with several links in simultaneous use. Also mentioned are some foreign first generation experimental communications satellites. G.G.

N67-19188 Radio and Space Research Station, Slough (England).
KINETHEODOLITE OBSERVATIONS OF SATELLITES RECEIVED BY THE SATELLITE ORBITS GROUP FROM MALTA FOR MAY 1966
1966 45 p *Its* Issue No. 20, Pt. 1
CFSTI: $3.00

Tables of Cinetheodolite observations from Malta made during May 1966 of Echo 1 (1960-09A), Echo 1 Rocket (1960-09B), Samos 2 (1961-01A), Ariel 1 Satellite (1962-15A), Ariel 1 Rocket (1962-15B), Star-rad (1962-58A), Midas 7 (1963-30A), Dash 2 (1963-30D), Echo 2 Rocket (1964-04B), Cosmos 44 Satellite (1964-53A), Cosmos 44 Rocket (1964-53B), Cosmos 55 Satellite (1965-11B), Cosmos 54 Rocket (1965-11D), Snapshot (1965-27A), and Pegasus 2 (1965-39A). The data consist of times, azimuths, and elevations. L.S.

N67-19357* Smithsonian Astrophysical Observatory, Cambridge, Mass.
CATALOG OF PRECISELY REDUCED OBSERVATIONS
18 Nov. 1966 166 p refs
(Grant NsG-87-60)
(NASA-CR-82599; SAO Special Rept.-227; P-15) CFSTI: $3.00 CSCL 22A

This astrophysical observatory special report catalogues the positions of artificial satellites obtained by the precise reduction of films taken at Baker-Nunn 12 camera stations. During this six-month period, all precisely reduced observations were checked by determining their residuals from the best obtainable orbits, and found to be without significant errors. The present catalog includes 410 observations of such satellites as: Vanguard 2, Vanguard 3, Echo 1 Rocket Body, Explorer 9, Transit 4A, Injun, Midas 4, Telstar 1, and A15 Relay. R.LI.

N67-19358* Smithsonian Astrophysical Observatory, Cambridge, Mass.
SATELLITE ORBITAL DATA
Beatrice Miller 20 Oct. 1966 178 p
(Grant NsG-87-60)
(NASA-CR-82598; SAO Special Rept.-225) CFSTI: $3.00 CSCL 22C

N67-19358

Baker-Nunn field-reduced photographs were used in calculating satellite orbit data for the tables presented. As opposed osculating elements, the elements presented are mean elements in the sense that the effects of the short-period perturbations due to the earth's oblateness have been eliminated. These mean elements are derived from observations covering several days and are given in the form of a table for satellites such as: Explorer I, Vanguard, Relay, Telstar, and Echo, Injun III. Smooth elements were derived from observations covering about 2 weeks or more, and are given as functions of time. R.LI.

1966
IAA ENTRIES

A66-19538
VHF GROUND-SATELLITE-AIRCRAFT RELAY USING SYNCOM III.
William M. Pulford (Bendix Corp., Bendix Radio Div., Baltimore, Md.).
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, ANNUAL EAST COAST CONFERENCE ON AEROSPACE AND NAVIGATIONAL ELECTRONICS, 12TH, BALTIMORE, MD., OCTOBER 27-29, 1965. TECHNICAL PAPERS. [A66-19487 08-21]
Conference sponsored by the Baltimore Section of the Institute of Electrical and Electronics Engineers, and the Aerospace and Navigational Electronics Group.
New York, Institute of Electrical and Electronics Engineers, 1965, p. 3.3.5-1 to 3.3.5-6.

Review of tests performed to study the feasibility of using a satellite as an active relay for communications between an aircraft in flight and a ground terminal. The Syncom II satellite was used for the tests, and its communications characteristics are outlined. On three flights, a series of listening and two-way communications tests were performed which demonstrate the feasibility of the concept. P.K.

A66-19974
ANTENNA SYSTEMS OF FOREIGN COMMUNICATION LINKS VIA ARTIFICIAL EARTH SATELLITES [ANTENNYE USTROISTVA ZARUBEZHNYKH LINII SVIAZI CHEREZ ISKUSSTVENNYE SPUTNIKI ZEMLI].
A. M. Pokras.
Edited by E. B. Korenberg.
Moscow, Izdatel'stvo "Sviaz'," 1965. 168 p. In Russian.

The aim of this book is to give a systematic compilation of information scattered in the literature on antenna systems employed in satellite communication links. The effect of antenna characteristics on antenna noise temperature and system SNR is outlined, and antenna rotating systems are examined. A discussion of ground-based antennas includes the single-reflector paraboloidal antenna, the antenna employed at Goonhilly Downs, various types of antennas used by mobile stations, two-reflector antennas, paraboloidal horn-reflector antennas, the two-reflector horn antenna, the spherical reflecting antenna system, and self-focusing antenna arrays. Also examined are ground-based antenna systems for satellite tracking, including the automatic tracking antenna for the Telstar communications satellite, a precision tracker and the Autotrack system (developed by the Bell Telephone Laboratories), and the principles of beam swinging by combining two types of oscillations, and the principles of conical scanning. The antennas employed on board the Telstar, Relay, Syncom, and Advent satellites are discussed. V.P.

A66-20169
AEROSPACE IN PERSPECTIVE - UTILIZATION.
Space/Aeronautics, vol. 45, Jan. 1966, p. 86-95.

Discussion of utilitarian applications for spacecraft such as communications, weather, geodetic, and navigation satellites and advanced high-speed aircraft. Synchronous-altitude satellites are described with capabilities of up to 6000 voice circuits, nationwide TV network distribution, and aircraft in-flight communications servicing. Wheel-mode Tyros-type satellites in polar sun-synchronous orbits can provide complete information on the earth's cloud cover and other meteorological phenomena. Satellites for carrying complete geodetic measuring systems are being programed; the Pageos satellite is a 100-ft-diam balloon which will soon be launched and will provide a point light source in space for precise triangulation photography. Plans for equipping the X-15 hypersonic aircraft with a delta wing and a scramjet engine are described. D.P.F.

A66-20250 #
ON THE TRACK OF WORLDWIDE SATELLITE COMMUNICATIONS.
Andrew G. Haley.
Astronautics and Aeronautics, vol. 4, Feb. 1966, p. 86, 87, 89.

Analysis of the effect on present communications systems of satellite communications. The length of time remaining before the advent of large-scale broadcasting of communications - both "sight and sound" and record communications - into individual homes is seen to be much more dependent on the solution of political, sociological, economic, and legal problems than on technical ones. It is concluded that there remains ample time to amortize and depreciate existing systems and to integrate them into the new complex. R.A.F.

A66-20545 #
10-KW 6-GC TRANSMITTER FOR COMMUNICATIONS BY MEANS OF ARTIFICIAL SATELLITES [TRASMETTITORE DA 10 KW. 6 GHZ. PER COMUNICAZIONI MEDIANTE SATELLITI ARTIFICIALI].
Luigi Monachesi.
Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 13th, Genoa, Italy, Oct. 12-16, 1965, Paper. 18 p. In Italian.

Description of two transmitters built for the Telespazio station at Fucino, Italy. The first one is a 2-kw type-HS-1040 Siemens transmitter, the second one is a 10-kw klystron-Varian type VA-884. M.M.

A66-20548 #
ITALY'S PARTICIPATION IN THE SYSTEM OF SPACE TELECOMMUNICATIONS [PARTECIPAZIONE DELL' ITALIA AL SISTEMA DI TELECOMUNICAZIONI SPAZIALI].
Marcello Rodinò.
Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 13th, Genoa, Italy, Oct. 12-16, 1965, Paper. 14 p. In Italian.

Discussion of the role played by Italy within the framework of COMSAT. The extent of Telespazio's participation in the network of space telecommunications is described. M.M.

A66-20559 #
RECEIVING EQUIPMENT FOR THE EARLY BIRD SATELLITE AT FUCINO [L'APPARECCHIATURA RICEVENTE DEL FUCINO PER IL SATELLITE "EARLY BIRD"].
Francesco Carassa (Milano, Politecnico, Milan, Italy) and Giovanni Battista Stracca (Società Generale di Telefonia ed Elettronica, Laboratorie Centrala F. Vecchiacchi, Milan, Italy).
Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 13th, Genoa, Italy, Oct. 12-16, 1965, Paper. 28 p. In Italian.

Brief description of the receiving equipment for satellite telecommunications installed at the Fucino station of Telespazio. The receiving equipment participates in commercial service tests of telecommunications by means of the Early Bird satellite. M.M.

A66-20561 #
THE ROLE OF SATELLITES IN WORLD COMMUNICATIONS.
Joseph V. Charyk.
Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 13th, Genoa, Italy, Oct. 12-16, 1965, Paper. 12 p.

Discussion of the future era of international satellite communications. Successful experiments conducted on two-way communications via a synchronous satellite between a ground station and a regularly scheduled commercial jet airliner have led to studies of the possibilities of a synchronous satellite system to meet the air-ground and ground-air communication needs of the airlines flying the international air routes of the world. Operations would be in the vhf band rather than in the microwave frequency bands set aside for normal communications satellite traffic. It is pointed out that a satellite that could meet the requirements appears well within the state of the art and could be launched to synchronous altitude by thoroughly qualified existing boosters such as, for example, the Atlas-Agena. M.M.

A66-20562 #
ROCKETS AND SPACE BOOSTERS FOR ORBITING TELECOMMUNICATIONS SATELLITES [MISSILI E TRASPORTATORI AEROSPAZIALI NELLA MESSA IN ORBITA DI SATELLITI PER TELECOMUNICAZIONI].
Cesare E. Cremona.
Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 13th, Genoa, Italy, Oct. 12-16, 1965, Paper. 10 p. In Italian.

Discussion of the practical utilization of telecommunications satellites, with emphasis on that facet of this activity which has been experimentally verified. The satellite telecommunications network is discussed together with the necessary launch vehicles.
M. M.

A66-20590
DIVIDING FILTER FOR SENDING AND RECEIVING AT THE RAISTING TRANSMITTING GROUND-STATION [DIE SENDE-EMPFANGS-WEICHE DER ERDEFUNKSTELLE RAISTING].
Rüdiger Teupser (Siemens und Halske AG, Munich, West Germany).
(Deutsche Gesellschaft für Raketentechnik und Raumfahrtforschung, Symposium über Datenübertragung und Navigation im Weltraum, Munich, West Germany, Apr. 8, 1965, Paper.)
Raumfahrtforschung, vol. 10, Jan.-Mar. 1966, p. 36-39. In German.

Description of the dividing filter which permits the simultaneous transmission and reception of information when communicating between satellites such as Telstar and the ground station at Raisting. The problem consists of decoupling the transmitting from the receiving channel while the 25 m Cassegrain parabolic antenna and horn parabola feed mechanism are being used for simultaneous transmission and reception. A circular polarizer, a polarizing filter, and a radial circular suppressor are described which makes it possible to transmit with several kw power while detecting signals of only 1 pw. The efficiency of this filter is such that, using a frequency of 4170 Mc for reception and 6390 Mc for transmission, the reflection factor is less than 2.5% and the decoupling effect more than 80 db.
D.P.F.

A66-21148 #
DIURNAL VARIATION OF THE IONOSPHERIC TOTAL ELECTRON CONTENT.
P. C. Yuen and T. H. Roelofs (Hawaii, University, Honolulu, Hawaii).
Journal of Geophysical Research, vol. 71, Feb. 1, 1966, p. 849-854. 8 refs.
Research supported by the University of Hawaii and NASA.

The integrated electron content of the ionosphere has been determined from measurements of the polarization angle received from Syncom 3 transmissions at 137 Mc. The mean diurnal variations of electron content for each of 6 months (Oct. 1964 through Mar. 1965) are presented. These monthly mean curves are consistent with the notion of an electron-density profile resembling the Chapman production function. However, the observed day-to-day variations are distinctly not Chapmanlike. They are discussed, and a classification system is suggested.
(Author)

A66-21534
COMMUNICATION AND TERRESTRIAL NAVIGATION APPLICATIONS FROM EARTH ORBITING SPACECRAFT.
Eugene Ehrlich (NASA, Washington, D.C.).
IN: SCIENTIFIC EXPERIMENTS FOR MANNED ORBITAL FLIGHT; PROCEEDINGS OF THE THIRD GODDARD MEMORIAL SYMPOSIUM, WASHINGTON, D.C., MARCH 18, 19, 1965. [A66-21517 10-30]
Edited by P. C. Badgley.
Washington, D.C., American Astronautical Society (AAS Science and Technology Series. Volume 4), 1965, p. 337-358. 9 refs.

Analysis of the use of unmanned and manned satellites in communications and navigation. The background of the use of these vehicles in such applications is discussed in detail, and the role of applications technology satellites (ATS) is outlined. The advantages of using direct broadcasting satellites and amploying communication-navigation series satellites and manned spacecraft are described. Finally the future plans of NASA regarding communications and terrestrial navigation satellites are noted.
B. B.

A66-21790 #
TELSTAR ORBIT PREDICTION METHOD - ACCURACY COMPARISON WITH OTHER ORBIT PREDICTION METHODS.
Anthony G. Lubowe (Bell Telephone Laboratories, Inc., Analytical Mechanics Dept., Whippany, N.J.).
AIAA Journal, vol. 4, Feb. 1966, p. 361-363. 8 refs.

An orbit prediction method, "VARPAR," developed as part of the tracking and prediction program for the Telstar satellites, was compared with four other prediction methods. VARPAR is an analytic solution of Lagrange's planetary equations including (for the purposes of this comparison) the first- and second-order effects of the second harmonic of the geopotential, and the first-order effects of the third and fourth harmonic. The other methods considered were Brouwer's solution in canonical variables using the von Zeipel technique; a modification of Brouwer's solution by the Aeronutronic staff; Izsak's solution using the Vinti potential; and a solution in spherical coordinates developed by Hall, Gawlowicz, and Vahradian. Information on these methods was taken from a comprehensive report by Arsenault, Enright, and Purcell. Prediction accuracy was investigated by comparing the in-track error committed by each of the five prediction methods. VARPAR was found to be generally more accurate than the other methods, usually by an order of magnitude or more. Also, it appeared to be superior in computation speed and comparable in computer storage requirements, although these characteristics are difficult to compare, since a different computer was used for the VARPAR runs.
(Author)

A66-21857
DESIGN OF A 4 GC/S NITROGEN-COOLED NON-DEGENERATE PARAMETRIC AMPLIFIER.
D. Chakraborty, G. F. D. Millward, and D. Geden (General Post Office, Research Station, London, England).
Radio and Electronic Engineer, vol. 31, Jan. 1966, p. 27-32. 9 refs.

The design of a 4 Gc nitrogen-cooled nondegenerate parametric amplifier suitable for installation at the focus of a dish antenna in a communication-satellite-system earth-station is described. Two single-diode amplifiers, each of 15 db gain and 70 Mc bandwidth to the -3 db points, are cascaded to provide a minimum gain of 30 db and a -3 db staggered tuned bandwidth of 60 Mc with 1 db ripple in the passband. The noise temperature of the amplifier including a cooled circulator when cooled to 77°K is 35 ±5°K (with contributions from the waveguide connections and external circuitry increasing the overall noise temperature to 46 ±5°K).
(Author)

A66-22436
SECTORIAL HARMONICS OF THE EARTH'S GRAVITATIONAL POTENTIAL.
Jose Osorio.
Spaceflight, vol. 8, Jan. 1966, p. 31-33.

Discussion of the second-degree sectorial harmonic of the earth's gravitational potential which is related to the 338-day variation in the period of revolution of Syncom 2 observed in the interval from July 1964 to Feb. 1965. The derived values for the constants are given. These values were used to identify the effects of the third-degree sectorial harmonic in secular variations observed in three other intervals. The derived values for the constants are also provided.
M. M.

A66-22454 #
ENGINEERING DESIGNS FOR A COMMERCIAL COMMUNICATIONS SATELLITE.
Eugene T. Jilg (Communications Satellite Corp., Spacecraft Engineering Dept., Washington, D.C.).
Astronautica Acta, vol. 11, Sept.-Oct. 1965, p. 287-293.

Report on the commercial communications satellite designs resulting from studies for three systems under consideration - (1) random medium altitude, (2) phased medium altitude, and (3) synchronous. The medium altitude random model weighed 131 lb, was spin stabilized, and employed a magnetic torquing coil for spin axis orientation. The medium altitude phased satellite weighed 250 lb, was gravity-gradient oriented by means of two deployable

30-ft masts, and effected damping by magnetic hysteresis through four additional deployable elements. Orbital phasing was accomplished by an H_2O_2 system for coarse correction and N_2 for fine correction. The synchronous satellite weighed 150 lb and included a phased array antenna. D.P.F.

A66-22477 #
ROTATION OF THE ECHO 1 AND 2 SATELLITES [SUR LA ROTATION DES SATELLITES ECHO I ET II].
F. Link (Académie Tchécoslovaque des Sciences, Institut Astronomique, Ondřejov, Czechoslovakia).
Astronomical Institutes of Czechoslovakia, Bulletin, vol. 17, no. 1, 1966, p. 16-21. In French.

Results of photoelectric photometry of the rotation of the Echo 1 and 2 satellites. Certain theoretical aspects relating to the measurements and to possible influences on the rotation are considered. The duration of the rotation, its variations with time, and the direction of the rotation relative to the revolution are determined for the period from Sept. 1964, to May 1965. From the results obtained a number of conclusions are drawn concerning the satellites. A.B.K.

A66-23045 #
TEMPERATURE FIELD OF THE ELEMENTS OF THE THIN-SHELLED SURFACES OF SATELLITES FOR RADIANT HEAT EXCHANGE [TEMPERATURNOE POLE ELEMENTOV TONKOSTENNYKH POVERKHNOSTEI SPUTNIKOV PRI LUCHISTOM TEPLOOBMENE].
V. M. Zaletaev.
Kosmicheskie Issledovaniia, vol. 4, Jan.-Feb. 1966, p. 116-127. In Russian.

Determination of the heat field of a thin-shelled surface being acted upon by a steady-state heat flux, in the case where the heat is being redistributed among the particles of the surface by means of radiant heat transfer. The solution is analyzed for spherical and cylindrical surfaces. Heat fields of the type studied exist on the surfaces of satellites of the Echo type, as well as in cylindrical, thin-walled, nonhermetic sections of other space apparatus. R.A.F.

A66-24150
PERMUTATIONS OF SATELLITE ASSIGNMENTS TO COMMUNICATION LINKS.
Iwao Sugai (System Sciences Corp., Falls Church, Va.).
IEEE, Proceedings, vol. 54, Feb. 1966, p. 325, 326. 8 refs.

Derivation of exact equations with which all permissible satellite-link assignments may be found for a communication-satellite scheduling program. The equations yield an instantaneous physical visibility matrix of ones (visibilities) and zeros (no visibilities) at each time mark. Only single-access satellites, which can serve only one link at a particular time mark, are considered. R.A.F.

A66-24320 #
AUTOMATIC POINTING OF A LARGE CONTROLLED ANTENNA FOR TRACKING COMMUNICATION SATELLITES [AVTOMATICHESKAIA NAVODKA BOL'SHOI UPRAVLIAEMOI ANTENNY DLIA SLEZHENIIA ZA SVIAZNYMI SPUTNIKAMI].
F. Dzh. D. Teilor.
IN: AUTOMATION OF CONTROL PROCESSES; INTERNATIONAL FEDERATION ON AUTOMATIC CONTROL, INTERNATIONAL CONGRESS, 2ND, TRANSACTIONS, BASEL, SWITZERLAND, AUGUST 28-SEPTEMBER 4, 1963 [AVTOMATIZATSIIA PROTSESSOV UPRAVLENIIA; KONGRESS MEZHDUNARODNOI FEDERATSII PO AVTOMATICHESKOMU UPRAVLENIIU, 2ND, BASEL, SWITZERLAND, AUGUST 28-SEPTEMBER 4, 1963, TRUDY]. [A66-24314 12-10]
Edited by A. Ia. Lerner.
Moscow, Izdatel'stvo Nauka, 1965, p. 366-377; Discussion, R. Dzh. Uiler and D. K. Loz'er, p. 377, 378. In Russian.

Description of a system for controlling the positioning of a large microwave antenna used for tracking communication satellites. The direction of the axis of the parabolic reflector is controlled by independently feeding control signals to mechanisms ensuring azimuth and elevation angle pointing. The data are presented on perforated tape and are computed at intervals of 1 sec or less. The positions of the horizontal and vertical axes are determined with the aid of separate servosystems, each of which switches on its respective comparator, digital-to-analog converter, Leonard drive unit, electromechanical dc drive, and device for computing the position of the shaft, the signal from which is fed back to the comparator. The system includes a control panel, by which pointing can be achieved by appropriate, manually chosen signals fed into the servosystem. The control panel has the additional function of feeding corrections to the control mechanism - i.e., additions or subtractions from the data presented on the perforated tape. A.B.K.

A66-24473 #
REPORT ON CLOCK PULSE SYNCHRONIZATION EXPERIMENT VIA RELAY II SATELLITE.
(Ministry of Posts and Telecommunications, Radio Research Laboratories, Ground Station Committee Meeting, 9th, Tokyo, Japan, Nov. 24-27, 1965, Paper.)
Radio Research Laboratories, Journal, vol. 12, Sept. 1965, p. 311-316.

Description of a joint experiment carried out by the U.S. Naval Observatory and the Radio Research Laboratories of Japan, with the aim of synchronizing the standard time pulses of the two nations. Relay 2 (1964 3A) was used to relay time pulses transmitted by ground stations at Mojave (COMMOJ) and Kashima (COMKAS). The standard clock of the Radio Research Laboratories is estimated to be 1329.6 (± 1.0) μsec ahead of that of the U.S. Naval Observatory. R.A.F.

A66-24735 #
THE IMPACT OF COMMUNICATIONS SATELLITES.
Winfred E. Berg (National Aeronautics and Space Council, Washington, D.C.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-260. 7 p.
Members, $0.75; nonmembers, $1.50.

Discussion of the future impact of communications satellites on society. Transmission techniques and antenna design can be developed to the point where use of the same frequency spectrum for synchronous satellites stationed 10° apart in the equatorial plane will be become feasible. This would provide more than one million voice channels between any two ground stations using satellites for the East-West link. Two most important developments will be the possibility of providing all individual users of communications facilities with facsimile newspapers from all over the world and the direct access to all libraries for the automatic retrieval and presentation of material. D.P.F.

A66-24736 #
EARLY BIRD PLACEMENT IN A STATIONARY ORBIT - LAUNCH AND CONTROL SYSTEM MANEUVERS.
Robert H. Greene (Communications Satellite Corp., Washington, D.C.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-262. 24 p. 10 refs.
Members, $0.75; nonmembers, $1.50.

This paper discusses the various Early Bird Hydrogen peroxide control system maneuvers necessary to get the satellite from its elliptical inclined transfer orbit into its final stationary position at 30°W. longitude over the equator. A brief discussion is given of the launch sequence and necessary tracking, polarization, and sun sensor telemetry information for the determination of the satellite orbit and the satellite attitude. Also treated is the hydrogen peroxide control system on Early Bird and the functions of the axial and radial jets in both the continuous flow and pulsed jet mode. The method of selection of the time of apogee motor firing and the necessary spacecraft attitude at apogee motor firing are examined, and the reorienta-

tion, axial, and radial jet velocity maneuvers required before and after apogee motor firing to synchronize and circularize the orbit and place the satellite at its desired longitude are considered. The effects of triaxiality on the long-term stability of the satellite orbit and the peroxide velocity corrections necessary to correct for this perturbation are investigated. (Author)

A66-24737 #
EARLY BIRD I COMMUNICATIONS PARAMETERS.
Simon B. Bennett (Communications Satellite Corp., Washington, D.C.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-263. 12 p.
Members, $0.75; nonmembers, $1.50.

Consideration of the primary mission of the Early Bird satellite: to provide uninterrupted two-way commercial quality communications between the North American and European continents. To this end, the satellite incorporates two broadband microwave repeaters which translate in frequency and amplify FM communications carriers. In the paper, the repeater configuration as well as those parameters of importance to communications are discussed. These parameters include effective radiated power, receiving sensitivity, bandwidth, and nonlinear performance. The correlation obtained between the prelaunch, the specifications, and the in-orbit values of these parameters is analyzed. Special measurement problems are also highlighted. (Author)

A66-24738 #
EXPERIMENTAL PERFORMANCE OF THE EARLY BIRD COMMUNICATION SYSTEM.
L. F. Gray (Communications Satellite Corp., Washington, D.C.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-264. 16 p.
Members, $0.75; nonmembers, $1.50.

A brief description of the characteristics of the earth stations used in the Early Bird communications satellite system is given. The experimental data taken in cooperation with European earth stations are discussed. Additional experiments conducted since launch, including simultaneous telephone and television transmission, simulated radar interference tests and tests with a shipboard station, are reported. The results of continuous observations of out-of-band noise and pilot signals during variable weather conditions and the effect of conjunction of the satellite with the sun are reported. (Author)

A66-24739 #
DESCRIPTION OF THE GLOBAL COMMUNICATIONS SATELLITE.
Morris Feigen, Neville J. Barter, and R. G. Slaughter (Thompson Ramo Wooldridge, Inc., TRW Systems Group, Redondo Beach, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-266. 16.p.
Members, $0.75; nonmembers, $1.50.

A description is given of the TRW design which was proposed to the Communications Satellite Corporation and the Interim Communications Satellite Committee for use as the Global Commercial Communication Satellite. The overall configuration resulting from applying these criteria to the stated communications requirements is a cylindrical, spin stabilized satellite 56 in. in diam and 37 in. high, approximately 250 lb. The two linear communications repeaters using tunnel diodes and traveling wave tubes operate in the assigned frequency range for civilian communications satellites (6 Gc uplink and 4 Gc downlink with a bandwidth of 225 Mc each and effective radiated power of 22.0 dbw each) permitting over 1200 two-way telephone conversations per satellite. Telemetry and command functions are combined with the wideband communications system. The antenna beam is pointed toward the earth by electronically despinning the antenna. Earth sensors provide signals to the despin system and to the ground to permit ground correction of spin axis orientation using redundant hydrazine propulsion systems. (Author)

A66-24740 #
THE INITIAL DEFENSE COMMUNICATION SATELLITE PROGRAM.
H. B. Kucheman, Jr. (USAF, Systems Command, Aeronautical Systems Div., Wright-Patterson AFB, Ohio), W. L. Pritchard, and V. W. Wall (Aerospace Corp., El Segundo, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-267. 12 p.
Members, $0.75; nonmembers, $1.50.

Discussion of a satellite which evolved from a system study conducted to provide the optimum communications to military users. A cut-away view of the satellite, and its major characteristics are shown. The satellite is spun about its principal axis of inertia, thus gyroscopically stabilizing the communication antennas. The communication capabilities of the satellite are shown. It is pointed out that this initial communication satellite program will establish a research and development communications satellite system in being, designed to lead eventually to an operational system through integration with the Defense communications system and capable of providing service to specified users of the National Communications System. M. M.

A66-24741 #
EXPERIENCE OF THE DEFENSE COMMUNICATIONS AGENCY (DCA) IN OPERATING PILOT SATELLITE COMMUNICATIONS.
W. H. Edwards (U.S. Defense Communications Agency, Washington, D.C.) and J. S. Smith (System Sciences Corp., Falls Church, Va.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-268. 20 p. 6 refs.
Members, $0.75; nonmembers, $1.50.

The technical characteristics and operational test performance of a military communication system comprised of synchronous satellites and several different types of earth terminals are presented in this paper. Particular emphasis is placed on the early use and capability of the Syncom II and Syncom III satellite communication systems to provide military long-haul operational test communications using both voice and teletype modulation modes. A brief discussion of the pilot data obtained from the experimental use of the Early Bird satellite is also included. Following a review of the developmental history and the orbital characteristics of Syncom II and Syncom III, a system model is presented showing the operational test communication system configuration, including the earth terminal assets and the satellites. Satellite availability for the above operational test system configuration is discussed briefly. The system performance (communications capacity available) is evaluated by comparing measured test data taken in the field with calculated power budget values. The major portion of this paper is concerned with system control aspects and operational test uses of the system in the day-to-day operation. A discussion of those factors affecting system reliability is also included. Finally, a review of personnel training and manning requirements for the earth stations completes the paper. (Author)

A66-24742 #
CURRENT STATUS OF THE INITIAL DEFENSE COMMUNICATIONS SATELLITE PROJECT.
R. C. Barthle (U.S. Defense Communications Agency, Communications Satellite Project Office, Washington, D.C.) and I. H. Riley (System Sciences Corp., Falls Church, Va.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-269. 8 p.
Members, $0.75; nonmembers, $1.50.

Discussion of the objectives of the Initial Defense Communications Satellite Project (IDCSP), the current status of the project and the extent to which the project will meet its planned objectives. The rather limited research, development, test and evaluation (RDT&E) objectives of the IDCSP are listed. The IDCSP system consists of four major subsystems, the launch and deployment subsystem, the satellite subsystem, the earth station subsystem, and the control subsystem. Each of these is discussed in detail. The IDCSP test program is described and its current status is reviewed. M. F.

A66-24743 #
NAVY ACHIEVEMENTS IN SATELLITE COMMUNICATIONS.
M. D. Van Orden (U.S. Navy, Bureau of Ships, Satellite Communications Project Management Office, Washington, D.C.) and E. N. Marsh (System Sciences Corp., Falls Church, Va.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-270. 20 p.
Members, $0.75; nonmembers, $1.50.

Review of USN contributions to space communications, of the present status of the USN Syncom program, of the technical characteristics of the Initial Defense Communications Satellite Project, and of plans for future use of satellite communications. The communications by moon relay (CMR) program is described. The characteristics of the specially designed 30-ft-diam satellite-tracking antenna aboard the Kingsport vessel are discussed. The major factors which restrict the design of a shipboard satellite communications terminal are considered in the light of USN requirements. The antenna would be of the Cassegrain type fed by a multimode four-horn monopulse feed system. The instantaneous bandwidth of the entire system is designed for 40 Mc, tunable over 500 Mc in 1-kc steps. The future of the USN satellite communications program is discussed. D.P.F.

A66-24745 #
COMMUNICATIONS VIA SEVERAL SATELLITES USING THE LINCOLN EXPERIMENTAL TERMINAL (LET).
Irwin L. Lebow (Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Mass.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-272. 12 p. 9 refs.
Members, $0.75; nonmembers, $1.50.

Review of various experiments performed using the Lincoln Experimental Terminal (LET) system. LET-1 is a self-contained air transportable terminal in two vehicles - an antenna trailer holding a 15-ft antenna and the rf equipment, and a signal processing van which houses the modulation, speech, teletype equipment, operating console, prime power supply, and the antenna storage locker. LET-2 operates using the Lincoln Laboratory's 60-ft terminals located in Mass. and Calif. LET-3 uses the 30- and 60-ft terminals at Camp Roberts, Calif. In all of the LET systems, energy transfer is minimized by sophisticated communication and source processing. D.P.F.

A66-24746 #
SOME ASPECTS OF THE COMMERCIAL COMMUNICATIONS SATELLITE SYSTEM - IMPACT AND PROBLEMS.
Asher H. Ende (Federal Communications Commission, Common Carrier Bureau, Washington, D.C.) and Maurice Wolf (Federal Communications Commission, Washington, D.C.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-273. 11 p.
Members, $0.75; nonmembers, $1.50.

Discussion of the manner in which the technical ability to position a satellite capable of repeating radio signals in synchronous orbit was converted into practical commercial use of outer space to provide high-quality, low-cost, worldwide communication services. The Communications Satellite Act of 1962 is reviewed. The formulation of international agreements for satellite utilization is discussed in terms of the novel problems which required solution. Problems which lie ahead in the future for satellite communications are enumerated. D.P.F.

A66-24748 #
MANPOWER PROJECTIONS AND PROBLEMS FOR COMMUNICATION SATELLITES.
William A. Earnshaw (Raytheon Co., Sudbury, Mass.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-275. 12 p. 9 refs.
Members, $0.75; nonmembers, $1.50.

The manpower requirements and problems of the present and proposed communication satellite programs are reviewed and their lessons for the future appraised. Where official timing and schedules have not been announced, these are estimated. The total manpower requirements for research, development, production and operation of each program are estimated by year. The sources of supply and likely problems of recruitment, education, training and mobility are discussed. The likely impact of the communication satellite manpower requirements upon the remainder of the economy are noted. This manpower problem is a continuing one and cannot be expressly defined in a single paper. However, with the general dimensions established, the tentative recommendations can be amended with experience and point the way for future manpower research. (Author)

A66-24749 #
COMMUNICATIONS IN ORBIT - A LEGAL ANALYSIS AND PROGNOSIS.
Jerome Morenoff (Planning Research Corp., Washington, D.C.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-277. 20 p. 25 refs.
Members, $0.75; nonmembers, $1.50.

Discussion of the legal aspects of communication satellites and a definition of law upon which such a discussion is based. The requirements of customary international law are reviewed. It is shown that the time element is the most difficult to define and that the necessary duration required for the development of customary law is a function of the community objectives, the general circumstances involved, and the frequency of occurrence. The problem of access to and peaceful uses of outer space in terms of international cooperation is examined. The resolutions and reports on the question of the legal status of outer space as prepared by international bodies and committees are reviewed. D.P.F.

A66-24750 #
MULTIPLE ACCESS MODULATION TECHNIQUES.
D. T. Magill (Philco Corp., WDL Div., Palo Alto, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-278. 10 p. 5 refs.
Members, $0.75; nonmembers, $1.50.

The performance of the following four basic multiple access techniques is reviewed: (1) frequency-division multiple access (FDMA), (2) time-division multiple access (TDMA), (3) spread-spectrum multiple access (SSMA), and (4) pulse-address multiple access (PAMA). Particular emphasis is placed on the effect of the satellite channel and future growth capabilities. It is concluded that for large terminals TDMA appears most desirable in the nonjammed environment and SSMA most desirable in the jammed environment. (Author)

A66-24751 #
A COMMUNICATION SATELLITE SYSTEM FOR MANY USERS.
R. S. Davies and J. M. Stephenson (Philco Corp., WDL Div., Palo Alto, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-279. 12 p.
Members, $0.75; nonmembers, $1.50.

Description of a time-division multiple-access (TDMA) modulation system for satisfying anticipated demand by many small users for communication satellite facilities. The satellite contains a hard limiting repeater of moderate bandwidth. The satellite beacon transmits a frame synchronization signal from which all users derive basic timing information. Individual time slots in the time division signal are assigned to individual users in accordance with their antenna terminal capabilities and data rate requirements. The system makes efficient use of the rf spectrum and satellite power with simple user control based on time-slot allocations. D.P.F.

A66-24753 #
SATELLITE TELECOMMUNICATIONS FOR THE EMERGING NATIONS.
R. C. Winterbottom (Hughes Aircraft Co., Aerospace Group, Space Systems Div., Los Angeles, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-281. 12 p.
Members, $0.75; nonmembers, $1.50.

Brief description of requisites and design principles applicable to the design of a worldwide multiple-access telecommunication system. The system is intended to provide inter- and intracontinental service to both large and small nations alike; special consideration is given, however, to the requirements of the less affluent nations. M.M.

A66-24754 #
REQUIRED AND ATTAINABLE INTERFERENCE RATIOS IN SPACE TELECASTING.
R. P. Haviland (General Electric Co., Philadelphia, Pa.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-283. 20 p. 16 refs.
Members, $0.75; nonmembers, $1.50.

Examination of factors involved in the space telecasting problem requiring a cochannel signal-to-interference ratio of 27 db, and antenna discrimination in accord with CCIR recommendation 419. Additional methods of interference control are considered with the objective of arriving at an understanding of required and attainable interference ratios. The 525-line system is used except as otherwise indicated. M.M.

A66-24755 #
TV NETWORKING SATELLITE SYSTEMS.
Samuel Gubin and James J. Hawley (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-284. 12 p.
Members, $0.75; nonmembers, $1.50.

This paper presents the results of preliminary studies to determine the feasibility of using synchronous stationary satellite systems for distribution (networking) of video and radio material to broadcast stations. Systems operating in two frequency bands are studied and compared. The 4 Gc internationally approved and shared band has a severe constraint in radiated spectral power flux density which leads to a lower power satellite and higher performance earth terminal than a 5 Gc system which, while not having the radiated power constraint, must confine its flux to the continental, contiguous U.S. to avoid the need for regional agreement. The transmission of a monotonic picture presents a severe problem in the 4 Gc band using conventional FM because the whole power of the satellite is concentrated in a single spectral line (neglecting the small synchronizing pulse power). The limit for power flux at the earth's surface in a 4 kc band, is now under consideration by the CCIR and may be limited to -152 dbw/m^2/4 kc. A modulation system which minimizes the impact of this constraint is described. The problem of confining radiation to the U.S. for the 5 Gc satellite is solved by the use of a number of beams which cover the country in a mosaic fashion. The study considers operational needs, and satellite designs to meet these needs. (Author)

A66-24756 #
LAUNCH VEHICLES AS SUPPORT SUBSYSTEMS FOR COMMUNICATIONS SATELLITES.
Barrett Bruch and Charles Wallin (Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Sunnyvale, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-285. 16 p.
Members, $0.75; nonmembers, $1.50.

Discussion of the necessity of suitably defining important launch vehicle parameters to properly develop and analyze optimum methods of satisfying commercial and government communications satellite systems requirements. The launch vehicle is considered a support subsystem having a cost typically amounting to about half of the total space hardware cost. Identification of launch vehicle interface and its capability to furnish the communications spacecraft with electrical power, a suitable environment, structural and dynamic support, and provision for dispensing are important. Launch vehicle reliability and confidence are major factors in determining program costs. Use of extensive existing ground support capability is important to minimize system cost. Likewise, program-peculiar support requirements should be minimized since expense of launch vehicle development and support modifications can be significant. M.M.

A66-24757 #
ESTABLISHMENT AND MAINTENANCE OF A COMMUNICATION SATELLITE SYSTEM.
David D. Werts (Thompson Ramo Wooldridge, Inc., TRW Systems Group, Redondo Beach, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-286. 16 p.
Members, $0.75; nonmembers, $1.50.

A number of factors involved in establishing a satellite system are considered which will affect the design of a communications satellite system. Phased and randomly spaced satellite systems in equatorial and inclined orbits with periods from 6 to 24 hr are investigated, considering user requirements. Constraints which determine the number of satellites are studied, including orbital altitude and inclination and adequate communications service to the users. With this background, the constraints due to launch vehicle limitations are outlined, including vehicle payload capability and launch window requirements. The numbers of boosters and satellites required to establish a system are presented. The effects of multiple satellites launched on one boost vehicle and multiple launches of boost vehicles are explored. The numbers of boosters and satellites required annually are estimated, based on satellite lifetime, number of orbit planes in the system and the number of spacecraft carried by each booster. Finally, the time required to establish a system is discussed on the basis of launch limitations, tracking requirements and satellite positioning. (Author)

A66-24758 #
SATELLITE COMMUNICATIONS CONTROL SUPPORT SYSTEM.
J. M. Rosenberg and E. J. Kelly (Philco Corp., WDL Div., Palo Alto, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-287. 12 p.
Members, $0.75; nonmembers, $1.50.

Description of the satellite communications control support system which consists of earth stations and satellite relays. The allocation of system resources is an important factor in utilizing the available system capacity and in achieving a reasonable cost per channel. The system receives validated communications requests or requirements from users on a prescheduled or demand basis, and schedules are generated for controlling the earth stations and their use of the satellite relays. The control concept can be either highly centralized, wherein a single control facility operates the entire global communications network directly, or decentralized, wherein area or regional facilities exercise considerable autonomy within a specific geographical region in accordance with policies and procedures established by the central facility. A measure of the effectiveness of the control system is the ratio of allocated resources to total resources available. The central support system described will accommodate earth stations of different rf characteristics and satellites in different orbits, rf power and antenna orientation. M.M.

A66-24759 #
SCHEDULING AND CONTROL OF SATELLITE COMMUNICATION SYSTEMS.

Ward Ellis and Morton D. Lenske (Litton Industries, Inc., Mellonics Systems Development Div., Sunnyvale, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-288. 16 p.
Members, $0.75; nonmembers, $1.50.

Examination of important parameters of a satellite communication system control problem and definition of the scheduling function of a satellite communication control system. Scheduling is expressed as the matching of communication requirements to system assets over a particular period of time. Essential elements of the scheduling process are discussed with the emphasis on the distinction between the scheduling model and the scheduling algorithm. The following relationships are defined: overall scheduling efficiency, scheduling model effectiveness, scheduling algorithm efficiency, and link terminal utilization efficiency. The paper concludes with a brief discussion of two types of scheduling algorithms which have been successfully implemented. M.F.

A66-24761 #
AN ADAPTIVE TWELVE CHANNEL MULTIPLEXER.
G. D. Hodge, C. A. Kengla, K. M. Roehr (International Business Machines Corp., Bethesda, Md.), and M. Malinowski (U.S. Army, Satellite Communications Agency, Fort Monmouth, N. J.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-291. 29 p. 7 refs.
Members, $0.75; nonmembers, $1.50.

Communications satellite systems used by the Department of Defense can be made more efficient through adaptive capabilities in ground terminal equipment. An automatic adaptive voice multiplexer for military use is described; its operational procedures and design philosophy are discussed. Several alternative multiplexing techniques were evaluated in order to find the most efficient modulation and multiplexing technique. The analysis procedure is outlined, and the results of a comparative analysis of six alternative techniques are presented. The selected technique is frequency division multiplexing of single sideband channel signals, with frequency modulation of a carrier by the multiplex signal. The system design implementing the selected approach is described with particular emphasis on the adaptive features and capabilities of the multiplexer. The adaptive sensing element and automatic digital logic control system are briefly described. (Author)

A66-24764 #
OPTIMIZATION OF NETWORK CONFIGURATIONS IN A HYBRID SATELLITE AND GROUND COMMUNICATION SYSTEM.
W. Nehl and H. Most (System Sciences Corp., Falls Church, Va.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-295. 12 p.
Members, $0.75; nonmembers, $1.50.

Discussion of concepts for adaptive utilization of communication satellite systems. The objective of these adaptations is to optimize the dynamic traffic handling capability of a combined ground and satellite communications complex. It is shown that adaptive routing and network adaptation are requirements for effective system optimization and are complementary considerations rather than substitutes for each other. The problem of network adaptation using communication satellites is defined in the classical terms of matching achievable branch capacity matrices to a given traffic demand matrix. However, it is indicated that for practical implementation an optimization algorithm based on relative link loading information could be more advantageous. This is because the system feedback information in terms of relative link loading figures could simultaneously be used for network adaptation, adaptive routing, and for network monitoring purposes. Thus, with minimum control traffic the desired objectives of real-time system adaptation and supervision can be attained. M.F.

A66-24765 #
A MULTIPLE-ACCESS WORLDWIDE SATELLITE COMMUNICATION SYSTEM FOR AIRCRAFT TERMINALS.
Malcolm L. Campbell (Boeing Co., Aerospace Group, Seattle, Wash.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-297. 16 p. 20 refs.
Members, $0.75; nonmembers, $1.50.

This paper describes a satellite system capable of providing worldwide communications for users having limited antenna gain, limited transmitter power, and relatively low data-volume requirements. While emphasis is placed on the problems associated with servicing aircraft terminals, the basic system concept is compatible with other types of users having similar terminal limitations. A minimum useful system consisting of a single, 10-channel, solid-state, quasi-linear repeater operating within the 100 to 500-Mc frequency range at synchronous altitude will provide teletype links between users within the coverage of the satellite. Global coverage with vocaded and/or FM voice service, in addition to teletype, is provided by a growth version of the minimum system. The channelized quasi-linear repeater concept, which employs separate hard-limiting receiving channels feeding a common solid-state linear power amplifier, eliminates the necessity for equalizing user up-link powers, minimizes crosstalk between channels, and reduces ECM vulnerability. Additional ECM protection can be added by frequency hopping the up-link and employing time-division multiple access, on a message basis, within the individual channels. (Author)

A66-24766 #
POWER SYSTEMS FOR COMMUNICATIONS SATELLITES.
Paul Bauer and Herbert Riess (Thompson Ramo Wooldridge, Inc., TRW Systems Group, Electric Power Laboratory, Redondo Beach, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-299. 20 p.
Members, $0.75; nonmembers, $1.50.

The requirements and design of electric power systems for current communications satellites are presented analytically. Attention is given to the effects of satellite mission and orbit upon the design, efficiency, and reliability of electric power equipment. Several specific electric power subsystem configurations are presented in block diagram form and analyzed for performance characteristics, efficiency, reliability, and applicability to communications satellites for various missions and orbital parameters. Reliability and redundancy techniques used in electric power subsystem components are discussed, with particular attention to minimizing weight and power losses. Component interfaces within the power subsystem are defined, as well as interfaces between the power subsystem and other subsystems typical of communications satellites. (Author)

A66-24767 #
A WIDEBAND SOLIDSTATE IF REPEATER FOR COMMUNICATIONS SATELLITE USE.
D. G. Horvath and S. Blum (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N. J.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-300. 12 p.
Members, $0.75; nonmembers, $1.50.

The COMSAT Phase-I study program was conducted jointly by the Astro-Electronics Division of RCA and Bell Telephone Laboratories to develop an 80 Mc solid-state i.f. repeater (for 270 duplex voice channels). The i.f. repeater developed utilizes a waveguide-cavity diode down converter, a transistorized i.f. amplifier, and a varactor up converter. This type of i.f. repeater lends itself to COMSAT system applications because of the high gains obtainable. The alternate, the rf repeater, requires either cascaded traveling wave tubes or a high-gain, tunnel-diode front end, followed by traveling-wave-tube amplification, to obtain comparable gains. The i.f.-type repeater

facilitates design of an AGC system that has the dynamic range necessary for systems in which different users' signals may vary widely in level. The feasibility of increasing the repeater bandwidth to 230 Mc (accommodating 600 duplex voice channels) was investigated. Laboratory confirmation of these goals was achieved. The operating parameters are: Input Signal - 5925 to 6155 Mc, I.f. Signal - 20 to 250 Mc, and Output Signal - 3970 to 4200 Mc. The results of the program indicate that there is no basic limitation to producing an all-solid-state i.f. repeater with 230 Mc bandwidth, exhibiting an overall noise figure of 11 db, which would be applicable to space communication systems. (Author)

A66-24768 #
ADVANCES IN TRAVELING-WAVE TUBES FOR SPACECRAFT COMMUNICATIONS SYSTEMS.
M. J. Schindler (Radio Corporation of America, RCA Electronic Components and Devices Div., Harrison, N.Y.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-301. 12 p. 7 refs.
Members, $0.75; nonmembers, $1.50.

Use of traveling wave tubes (TWT) for global satellite communications, this representing, at present, the only practical output device. Overall tube efficiency has risen to 42% at a power level of 30 watts, and over the whole range of 5 to 50 watts, the overall efficiency exceeds 35%. The same tube can thus be used for a variety of applications, including multiple-carrier, multiple-access systems. Low AM to PM conversion reduces intermodulation problems. By novel component tests, unusual stability against oscillation has been achieved. F.R.L.

A66-24770 #
GRAVITY GRADIENT STABILIZATION OF COMMUNICATION SATELLITE SYSTEMS.
R. G. Moyer and R. J. Katucki (General Electric Co., Missile and Space Div., Spacecraft Dept., Philadelphia, Pa.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-303. 16 p. 6 refs.
Members, $0.75; nonmembers, $1.50.

Description of the requirements for gravity gradient stabilization for medium and synchronous altitude (random and spaced) communication satellite systems. Communications satellite payloads launched to date have been spin stabilized with essentially zero gain antennas, and studies have shown that communication efficiency must be improved to be practical. Effective gains of 10 db at medium altitude and 14 db at synchronous altitude can be realized by using a directional antenna and stabilizing the satellite to the local vertical by gravity gradient. Stabilization accuracy, right-side-up capture, station keeping effects, and the effects of the various disturbance torques on system design are discussed. Flight test history of gravity gradient stabilized satellites and future flight plans are summarized. F.R.L.

A66-24772 #
NUCLEAR POWER SYSTEMS FOR ADVANCED HIGH-POWERED COMMUNICATIONS SATELLITES.
J. D. Gylfe (North American Aviation, Inc., Atomics International Div., Canoga Park, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-305. 20 p.
Members, $0.75; nonmembers, $1.50.

A survey of the nuclear power systems which are considered to be most suitable for advanced, high-powered communications satellites and which can be available in the 1970 to 1975 time period is presented. The general criteria for communication satellite power systems are discussed and candidate power systems which might be expected to meet these criteria are identified. A description and summary of the major design and performance characteristics of reactor, radioisotope, and solar-photovoltaic power systems are presented and compared for a range of power levels up to ~20 kwe. A nuclear-powered communication satellite concept is described and compared with a typical solar-powered concept on a total mission cost basis. It is concluded that the reliability and lifetime criteria dictate the use of passive, thermoelectric power conversion equipment for the nuclear power systems which could be made available in the 1970-1975 time period, and that reactor-thermoelectric systems offer the most attractive power system for advanced, high-powered communication satellites, based on overall mission cost considerations. (Author)

A66-24773 #
THE DEVELOPMENT OF HIGH GAIN DEPLOYABLE ANTENNAS FOR COMMUNICATION SATELLITES.
Samuel Allen Milliken (Hughes Aircraft Co., Aerospace Group, Space Systems Div., El Segundo, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-306. 12 p. 8 refs.
Members, $0.75; nonmembers, $1.50.

Spacecraft communication link antenna design is examined from the points of view of design limits and design approaches. Earth coverage from synchronous orbit and attitude stability and accuracy establish beam width limits of 20 and 0.7°. Area coverage antennas for high power satellites should be of the umbrella construction. Point to point communications requiring high gain spacecraft antennas may be effected by petaline-type antennas. (Author)

A66-24776 #
FEASIBILITY MODEL OF A DIRECT-TO-HOME TV SATELLITE SYSTEM (HTVS) FOR A 1969 LAUNCH.
R. B. Marsten and S. Gubin (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-309. 12 p.
Members, $0.75; nonmembers, $1.50.

A model of a direct-to-home TV broadcasting satellite system for the upper uhf frequencies is described in sufficient detail to establish feasibility for an early launch. Receiver installations provide pictures up to Class II, depending on cost, which is estimated as not exceeding $50. Stabilization is two-step, with fine beam control achieved by a sequential lobing tracker whose error signals provide controlled warp of a long boom. A multiport feed is carried on the boom (F/D = 0.44). Thermal control is conductive, and the power amplifier consists of four highly derated tubes working into a three-bridge diplexer. High efficiency techniques include pulse modulation for sync only and a unique high voltage solar array design. The antenna is a ribbed unfurlable array with less than 0.3 db maximum gain loss at 800 Mc, capable of receiving from any point in the U.S. while the transmitting beam axis is directed to any other. (Author)

A66-24780 #
SOME DESIGN CONSIDERATIONS FOR PLANETARY RELAY COMMUNICATIONS SATELLITES.
Roger D. Bourke and Thomas A. Barber (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-314. 12 p. 6 refs.
Members, $0.75; nonmembers, $1.50.

This paper discusses several items which affect the total information transmitted from a payload landed on a remote planet to the earth via a relay communications satellite. The parameters considered include the orbit of the communications satellite and its affect on the lander-orbiter communications geometry, the transmission policy which maximizes the information returned, and the effect of orbit injection errors on the degradation of communications capability. Transmission policy, as used here, is a collective term which includes the lander orbiter information rate, the criteria for initiating and terminating transmission, and mechanization of the desired sequence of events. Criteria for orbit selection other than

relay communications capability are delineated. It is shown that there are areas of conflict, and a reasonable basis for tradeoffs is given. Planetary orbit injection errors create a distribution of lander-orbiter transmission geometries about the nominal. The paper examines the optimum transmission policy in the light of these injection errors, and it is shown that, for certain magnitude errors, some transmission policies are merely degraded. (Author)

A66-24781 #
LUNAR COMMUNICATION SATELLITES.
George E. Neuner (Thompson Ramo Wooldridge, Inc., TRW Systems Group, Redondo Beach, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-315. 16 p. 27 refs.
Members, $0.75; nonmembers, $1.50.

Consideration of the following two types of communications satellite systems: (1) a system of many small, uncontrolled, nonoriented satellites in random lunar polar orbits; and (2) a system of two to six larger oriented satellites in precisely controlled synchronous lunar orbits. The satellite design for each system is briefly discussed, and an analysis is made to determine the expected cost for establishing and maintaining several representative lunar communications satellite systems. It is concluded that terrestrial comsat development can be largely used for the production of lunar comsats. A random system appears to be considerably more expensive than a synchronous system, the latter costing on the order of $200 million over a 10-yr period. M.M.

A66-24782 #
DEEP SPACE OPTICAL COMMUNICATIONS.
C. W. Chapoton and J. W. White (Westinghouse Electric Corp., Atomic, Defense and Space Group, Surface Div., Baltimore, Md.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-317. 12 p.
Members, $0.75; nonmembers, $1.50.
Contract No. NAS 9-3650.

Communications requirements (for telemetry and real time television) are developed for a manned deep space mission and for an orbiting laboratory of the Apollo extended mission type. Communications systems are synthesized to satisfy these requirements using direct optical links for both missions; a relay link using microwaves to a synchronous satellite with optical wavelengths to the manned deep sapce vehicle are considered. PPM, PCM/PL, and coherent reception are considered for each link. These systems are analyzed and the best modulation technique chosen for each link. Parametric tradeoff curves and system parameters are presented showing PPM to have a power advantage on the uplinks and PCM/PL on the downlinks. (Author)

A66-24792 #
BUSINESS FORECASTS FOR COMMUNICATION SATELLITE SYSTEMS.
J. Baer and L. B. Early (Hughes Aircraft Co., El Segundo, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-322. 12 p.
Members, $0.75; nonmembers, $1.50.

Discussion of long-range projections of the demand for intercontinental communications and their use as the basis for business decisions. General guidelines for those interested in the mechanics of projecting and forecasting the global system are provided. In the discussion, a hypothetical Latin American country, "Latina," is considered as an example of the forecasting techniques typically utilized in evaluating the business potential of constructing an earth station and thus adding any given country to the system. F.R.L.

A66-24795 #
GAIN LIMITS OF ELECTRONICALLY DESPUN ANTENNAS FOR COMMUNICATION SATELLITES.
Stephen N. Andre and Dennis J. Leonard (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Williamsville, N.Y.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-325. 12 p.
Members, $0.75; nonmembers, $1.50.

Study of the operational and system considerations involved in implementing an electronically despun satellite antenna system. The limits, beyond which these extensions are considered to be impractical because of excessive weight, control power, or complexity, are established, the beam forming and steering operations in the despun plane are discussed, and the techniques required to obtain higher directivity are given. It is shown that the beam forming and steering in the plane normal to the despun plane can be readily obtained by stacking of biconical type horns. Electronically despun antenna system weight, required control power, size, and actual gain are considered as a function of antenna beamwidth. B.B.

A66-24796 #
SELF-STEERING ARRAYS FOR SATELLITE APPLICATIONS.
W. H. Kummer (Hughes Aircraft Co., Aerospace Group, Antenna Dept., Culver City, Calif.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-326. 16 p.
Members, $0.75; nonmembers, $1.50.
Contract No. NAS 5-3545.

Review of the application of electronic self-steering techniques to satellite communication systems with high-gain antennas. The operation and performance of two experimental self-steerable arrays is described. The transdirective array uses Butler matrices to form a high-gain antenna that receives incident signals from arbitrary directions and processes them with amplification and frequency translation before reradiating the signals toward other directions. The second model is a type of self-phasing array: these are composed of conformal arrays of elements, each of which has its own electronic circuitry. An overall assessment is made of both systems, and an extrapolation to the implementation of larger systems with wider bandwidths is considered. B.B.

A66-24797 #
PARAMETRIC TRADE-OFF ANALYSIS FOR COMSAT SYSTEM DESIGN.
Robert J. W. Price (Technical Communications Corp., Lexington, Mass.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-330. 20 p. 6 refs.
Members, $0.75; nonmembers, $1.50.

Description of a methodology for a parametric analysis, penalty-effectiveness tradeoff, and system selection procedure for a communications satellite system. The methodology is structured in the form of a block digital computer synthesis, in which basic subroutines describing operational requirements, traffic analysis, electronic characteristics, orbital characteristics, system control, and penalty-effectiveness evaluation are developed. Thus, in each subroutine area, a large number of parametric interactions is considered, and, after a degree of suboptimization, related in terms of key parametric interactions between subroutines. The result is a digital synthesis program which is expected to provide meaningful input and tradeoff data to the management and engineering evaluators whose responsibility is optimum system selection to meet some specified need.
R.A.F.

A66-24799 #
ORGANIZATION AND PROGRAM OF "INTELSAT."
Edwin J. Istvan (Communications Satellite Corp., Washington, D.C.).
American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-332. 8 p.
Members, $0.75; nonmembers, $1.50.

Survey of the organization, purposes, and program of the International Telecommunications Satellite Consortium (INTELSAT). A partnership of the signatories of two international agreements formulated in 1964, INTELSAT is responsible for the construction and operation of the satellites used in a telecommunications satellite system and the equipment and facilities required for their control. The partners - the signatory nations and their communications entities - share the ownership and expenses of the consortium in proportion to their projected international telephone traffic for 1968; among them they account for over 90% of the potential international telecommunications traffic that might be served by a global satellite system in the next few years. R.A.F.

A66-25640 #
ANTENNA DRIVE SYSTEM FOR RADIO TELESCOPE ON RÅÖ.
Vilmos Török (Allmänna Svenska Elektriska AB, Semi-conductor and Electronics Div., Västeras, Sweden).
ASEA Journal, vol. 38, no. 10-12, 1965, p. 155-157.

Description of the antenna drive system for the radio telescope on Råö which was built for tracking telecommunication satellites and for radio astronomical studies. The position-control system receives its reference value from one coarse and one fine inductive position transducer. The principle of divided reset is used in the fine-control system: part of the feedback is taken from the antenna axis directly and a supplementary part is taken from the drive motor shaft. The position error is fed to an operations amplifier; the speed error is also amplified in a P operation amplifier with an output voltage which constitutes the reference current. The amplifier for amplifying current error has an output voltage which controls the excitation of the generator. D.P.F.

A66-25780
GUIDED PROPAGATION IN THE IONOSPHERE AND ITS POTENTIAL USE FOR GLOBAL COMMUNICATIONS.
Mario D. Grossi (Raytheon Co., Advanced Development Laboratory, Wayland, Mass.).
Electronic Progress, vol. 9, no. 2, 1965, p. 1-11. 5 refs.

Discussion of the possibility of implementing actual global communication systems by a scheme using the lower ionosphere for waveguidance of hf and vhf waves. The analytical techniques for a computer simulation of the phenomenon of the whispering gallery are outlined; the results were sought to prove theoretically the validity of the hypothesis that a whispering gallery can be supported by the lower ionosphere in the hf/vhf band, and to provide data on its expected performance. A method conceived to prove experimentally the existence of the phenomenon is illustrated. The method calls for the orbiting of two satellites, one transmitting and one receiving, in the ionospheric region where the phenomenon is expected to take place. M.M.

A66-25858
SPACE SCIENCE AND COMMUNICATIONS SATELLITES [WELTRAUMFORSCHUNG - NACHRICHTENSATELLITEN].
W. Nestel (Telefunken AG, Berlin, West Germany).
(Technische Hochschule Hannover, Hochschultag, Hanover, West Germany, Oct. 30, 1965, Vortrag.)
Flugwelt, vol. 18, Mar. 1966, p. 189-193. In German.

Review of the design and principles of operation of the Relay, Telstar, Syncom, Early Bird, and project-ATC communications satellites. The electronics involved in the launching and operation of a communications satellite are discussed and illustrated. The subminiaturization, micromodule, integral thin-film, and integral semiconductor techniques and their applications in communications-satellite design are examined. The warning is sounded that a country which does not place sufficient emphasis on space research and development is bound to lag behind the leading countries and be unable to compete with these even in fields that are not directly associated with space science. V.P.

A66-26321 #
VISIBILITY OF THE ECHO SATELLITES IN 1966 [VISIBILITE DES SATELLITES ECHO EN 1966].
Jean Meeus and Fritz Verhelst.
Ciel et Terre, vol. 81, Nov.-Dec. 1965, p. 417-424. In French.

Forecasts of the periods of brilliant visibility for satellites Echo I and II for the year 1966, especially for the latitude of Belgium. It is seen that as in previous years the orbit of Echo I will undergo important changes as to eccentricity. A table is given which lists the periods when Echo I will be visible in Belgium, extending from November of 1965 to February of 1967. A similar table is given for Echo II but with a greater degree of precision due to the fact that the nodal period of the satellite shows only small annual variations. D.P.F.

A66-27273
PHOTOGRAPHIC OBSERVATIONS OF THE ENTRY OF ECHO II INTO THE EARTH'S SHADOW.
L. M. Genkina, N. N. Denisiuk, and E. S. Eroshevich (Akademiia Nauk Kazakhskoi SSR, Institut Astrofiziki, Alma-Ata, Kazakh SSR).
(Astronomicheskii Zhurnal, vol. 42, Sept.-Oct. 1965, p. 1117-1119.)
Soviet Astronomy, vol. 9, Mar.-Apr. 1966, p. 864-866. 6 refs.
Translation.

A66-27824 #
ON THE ORBITAL ECCENTRICITY OF THE BALLOON SATELLITES.
Jean Meeus.
British Astronomical Association, Journal, vol. 76, Feb. 1966, p. 103-110.

Mathematical analysis of the orbital eccentricity of the balloon satellites Echo 1, Echo 2, and Explorer 19. The influence of the sun's radiation pressure on the satellites is determined. The orbital parameters of satellite 1963-30D for the period Dec. 1964 through Oct. 1965 are listed, and it is predicted that at the end of May 1966 its orbital eccentricity will be of the order of 0.11, with a perigee of 2500 km. Data for Echo 2 are also compared with calculated values, and close agreement is found. Predicted values of the orbital parameters of Echo 2 for the period Oct. 1965 through Mar. 1966 are given. Calculations for Explorer 19 also show close agreement with actual variations of eccentricity. M.L.

A66-27889 #
SYNCOM ELECTRICAL POWER SYSTEM.
P. S. DuPont (Hughes Aircraft Co., Aerospace Group, Space Systems Div., Communications Satellite Power Section, Los Angeles, Calif.).
(American Institute of Aeronautics and Astronautics, Annual Meeting, 1st, Washington, D.C., June 29-July 2, 1964, Paper 64-456.)
Journal of Spacecraft and Rockets, vol. 3, Apr. 1966, p. 593, 594.

A66-27898
HIGH-PERFORMANCE HYDROCARBON FUEL CELLS WITH FLUORIDE ELECTROLYTES.
E. J. Cairns (General Electric Co., Research Laboratory, Schenectady, N.Y.).
Nature, vol. 210, Apr. 9, 1966, p. 161, 162. 10 refs.
Army-supported research.

Description of an attempt at increasing the solubility of hydrocarbons in a cesium-salt fuel cell electrolyte by replacing some of

the carbonate anion by fluoride. Hydrofluoric acid is known to enhance the solubility of saturated hydrocarbons in aqueous solution and it appears that the fluoride anion is probably not adsorbed. Some of the results obtained in the series of experiments are shown. They indicate that the product of the solubility and diffusion coefficient for propane in the electrolytes resulting from more than six 25-cc additions of 48% hydrofluoric acid (original electrolyte volume, 200 cc) is significantly greater than in the initial cesium carbonate electrolyte. M.M.

A66-28361
COMMUNICATIONS SATELLITES - 1966 AND BEYOND.
Robert Henkel.
Electronics, vol. 39, May 2, 1966, p. 83-95.

Survey of the prospects for future growth in the use of communications satellites. A brief outline is given of the role of Comsat in commercial communications satellite development and of the tentative launching schedule of Comsat through 1969, special mention being made of the Early Bird and the Blue Bird series. The possibilities of using these satellites in aircraft control, home TV, and weather prediction are ascertained. Efforts to increase the rf power output of satellites in order to retain high reliability are described. A proposed power scheme involving the pneumatic deployment of solar-cell arrays is discussed. Military systems and the prospects for the development of a tactical satellite belt are also considered. A.B.K.

A66-28362
MILITARY SERVICES' SATELLITES WILL RING THE EARTH.
Jay J. Cohen (U.S. Defense Communications Agency, Communication Satellite Project Office, Washington, D.C.).
Electronics, vol. 39, May 2, 1966, p. 96-99.

Survey of the prospects for development of military satellites. An initial satellite-communication network consisting of a worldwide network of ground stations and 15 to 22 satellites randomly spaced in near-synchronous equatorial orbits is described. The operation of these satellites as real-time repeaters is discussed, as well as the problem of eliminating the radiation losses of their omnidirectional antennas. The ground-terminal network is described briefly, emphasizing the need to increase their multiple access capability. A.B.K.

A66-28364
SATELLITES TO BE AIRLINERS' TRAFFIC COP.
Nathaniel Braverman (Federal Aviation Agency, National Aviation Facilities Experimental Center, Atlantic City, N.J.).
Electronics, vol. 39, May 2, 1966, p. 104-106.

Survey of the prospects for the development of communications satellites for aircraft traffic control. A proposed one-satellite synchronous satellite system for over-ocean surveillance - using a gravity-gradient-stabilized satellite - is described. The results of research on various two-satellite systems are cited. Such systems are found to be very accurate except for the area near the equator. Various other surveillance systems are discussed, including a system where microwave radars are mounted on anchored floating ocean platforms or ships. A.B.K.

A66-28402 #
COMMUNICATIONS SYSTEMS UTILIZING PASSIVE SATELLITES
Robert T. Hart (Collins Radio Co., Dallas, Tex.).
IN: THE CHALLENGE OF SPACE; PROCEEDINGS OF THE THIRD SPACE CONGRESS, COCOA BEACH, FLA., MARCH 7-10, 1966. [A66-28401 14-30]
Congress sponsored by the Canaveral Council of Technical Societies. Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1966, p. 1-20.

Outline of the history of the passive satellite communications experiments to date and proposal of solutions to the deficiencies that have been indicated. The solutions include a preview of studies of new materials and satellite configurations. Communications system capability utilizing the proposed satellites is studied in detail for conventional and specialized networks. Experience gained from the Echo 1 and Echo 2 satellites has verified communication system parameters and the pending trials on new satellites will verify the new material concepts. M.F.

A66-28405 #
ADVANCED TRACKING AND COMMUNICATION SATELLITES.
C. M. Kelly and W. C. Reynolds (Goodyear Aerospace Corp., Akron, Ohio).
IN: THE CHALLENGE OF SPACE; PROCEEDINGS OF THE THIRD SPACE CONGRESS, COCOA BEACH, FLA., MARCH 7-10, 1966. [A66-28401 14-30]
Congress sponsored by the Canaveral Council of Technical Societies. Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1966, p. 51-68. 8 refs.

This paper describes a synchronous-orbit tracking and communication satellite that uses a large electronically steered antenna in conjunction with tracking interferometers and low-powered solid-state transmitter-receiver components. The system will track and communicate with target vehicles that are equipped with a dipole-type antenna, uhf receiver, and a 10-w transmitter. The satellite uses the spherical reflector and the associated packaging and deployment techniques that were analyzed and ground tested in connection with passive communication satellite programs. A spherical reflecting structure will serve as the vhf/uhf communication link antenna reflector and as a support for the uhf tracking interferometer antennas. Electronic steering is accomplished by a multiple-feed system that is located in the focal area of the spherical antenna reflector. Target location, trajectory and orbit parameter data processing, system control, and housekeeping functions will essentially be accomplished at a master ground terminal from the data exchanged with the satellite over a low-powered wideband duplex data link operating at X band. Tracking satellite attitude and yaw angle are also determined at the master ground terminal from signals radiated from the uhf satellite interferometer antennas and polarization vector of the X-band antenna signal respectivity. Finally, this paper presents data concerning the electronic system, satellite configuration, payload weight and volume, tracking accuracy, system coverage, antenna beam steering, system trades, data links, ground terminal, and other satellite applications. (Author)

A66-30071 #
STUDIES OF THE LATITUDINAL VARIATIONS OF IRREGULARITIES BY MEANS OF SYNCHRONOUS AND 1000 KM SATELLITES.
H. E. Whitney, R. S. Allen, and J. Aarons (USAF, Office of Aerospace Research, Cambridge Research Laboratories, Space Physics Laboratory, Radio Astronomy Branch, Bedford, Mass.).
COSPAR, International Space Science Symposium, 7th, Vienna, Austria, May 10-19, 1966, Paper. 17 p. 8 refs.

Study of the pattern of latitude effects on scintillation phenomena using 1000 km altitude satellites at 20, 40, 41, and 54 Mc, recordings of 136-Mc telemetering transmissions from the Early Bird synchronous satellite, and radio star observations at several frequencies between 30 and 1400 Mc. The sharp increase of scintillation index at high latitudes and the lack of it at low latitudes when observed at equal elevation angles is demonstrated. The studies on latitude dependence and distributions of scintillation index were made during the years of sunspot minimum; seasonal change seems to be a minor factor. D.P.F.

A66-30084 #
VARIATIONS IN EXOSPHERIC DENSITY NEAR SOLAR MINIMUM.
G. E. Cook (Ministry of Aviation, Royal Aircraft Establishment, Farnborough, Hants., England).
COSPAR, International Space Science Symposium, 7th, Vienna, Austria, May 10-19, 1966, Paper. 13 p. 17 refs.

Evaluation of the density of the upper atmosphere in the region of 1100 km from the change in the orbital period of Echo 2 for dates between Feb. 1964 and Dec. 1965. The air density shows a pronounced semiannual variation, while the variation between day and night is unlikely to exceed a factor of 2. M.F.

A66-30667
AN INTERNATIONAL AIRLINE VIEWS NAVIGATION SATELLITES.
R. R. Bohannon (Pan American World Airways, Inc., Miami, Fla.).
(Institute of Navigation, Annual National Meeting, Long Beach, Calif., June 21-23, 1965, Paper.)
Navigation, vol. 13, Spring 1966, p. 23-28.

Consideration of navigation satellites as a monitoring device to be used similarly to domestic radar, the cost of which could be kept to a minimum by integrating navigational hardware into a communications satellite for ATC. Results of flight tests using Syncom 3 are presented, with brief descriptions of the receivers and antennas. There is an urgent need for a research and development satellite with greater power output. Much emphasis needs to be put on development of an operational aircraft antenna. F.R.L.

A66-30877
COMMUNICATIONS IN SPACE.
Leonard Jaffe (NASA, Office of Space Science and Applications, Washington, D.C.).
New York, Holt, Rinehart and Winston, Inc., 1966. 176 p. $2.95.

This book is a survey of the subject of communications satellites. The various systems approaches are described, and several sorts of power systems are outlined. The passive satellite systems - such as Echo and West Ford - are considered. The design, testing, and operation of the satellites Score, Courier, Telstar 1 and 2, Relay 1 and 2, and Syncom 1, 2, and 3 are described. The earth-based ground systems of the satellite system are treated. The orbital environment of the satellites is discussed, both in terms of its usefulness and in terms of its deleterious effects on spacecraft lifetime. Comsatco and the Communications Satellite Act of 1962 are examined. The future of satellite communications and communications satellites is surveyed. R.A.F.

A66-30898 #
APPLICATION OF BERYLLIUM ON THE AGENA.
M. J. Rebholz (Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Structures Dept., Sunnyvale, Calif.).
(AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS, STRUCTURES AND MATERIALS CONFERENCE, 6TH, PALM SPRINGS, CALIF., APRIL 5-7, 1965, p. 321-329.)
Journal of Spacecraft and Rockets, vol. 3, May 1966, p. 715-722. 12 refs.

A66-31650
A MILITARY COMMUNICATION SATELLITE SYSTEM.
John H. Battison (Illinois Institute of Technology, Research Institute, Electromagnetic Compatibility Analysis Center, Frequency Allocation Group, Annapolis, Md.).
Microwave Journal, vol. 9, May 1966, p. 89, 90, 92, 93.

In order to enlarge and protect the DCS network so that it can continue to function in the face of sabotage or global war as well as to overcome natural hazards in new operational spheres, the incorporation of satellite communication links into DCS should be by conventional circuitry. Single circuit random access satellites are currently practical, but the need is foreseen for multiple access, multicircuit satellites. (Author)

A66-31816
INTERFERENCE BETWEEN TERRESTRIAL LINE-OF-SIGHT RADIO-RELAY SYSTEMS AND COMMUNICATION-SATELLITE SYSTEMS.
P. B. Johns (General Post Office, Engineering Dept., London, England).
Electronics Letters, vol. 2, May 1966, p. 177, 178. 5 refs.

A graphical method for obtaining transfer factors for interference problems involving wide-deviation frequency-modulated satellite systems is extended to problems involving interference between line-of-sight radio-relay systems and unloaded and undispersed satellite systems. Interference problems involving single-sideband amplitude-modulated systems are also considered. (Author)

A66-31935
COMMUNICATIONS SATELLITES. II - DESIGN CHOICES FOR THE FUTURE.
Donald D. Williams.
Electronics, vol. 39, May 30, 1966, p. 109-116.

Description of the design approach to operational communications satellite systems to meet the needs for the next 10 yr. With minor repeater modifications, this design is suitable for network or educational television distribution as well as general commercial use. Having a diameter of 9 ft and a length of slightly less than 10 ft, the satellite proposed would weigh 750 lb after burnout of its solid-propellant apogee motor. It would be launched by an Atlas-Agena vehicle. M.M.

A66-31936
LATEST WORD IN SPACE TALK - IT CAN COME FROM ANYWHERE.
William Korvin (NASA, Goddard Space Flight Center, Communication Research Branch, Greenbelt, Md.) and George G. Chadwick (Radiation Systems, Inc., Alexandria, Va.).
Electronics, vol. 39, May 30, 1966, p. 117-126.

Description of the development of a phased-array antenna that can transmit a focused beam in any direction and also receive with high gain. Its multiple directivity and gain make it ideal for aerospace communications. The engineering model is shown. It points its beams in 88 directions and has exhibited gains of 13 to 16 db at 1700 Mc and 2270 Mc (S band). It is a cylinder that has 64 circular apertures in 16 banks of four around its circumference, plus 12 circular apertures on each end, providing total coverage over 4π steradians. The model was successfully tested. M.M.

A66-32472 #
ON TIME-DEPENDENT COVERAGE AREAS OF COMSATS IN ELLIPTIC ORBITS.
Iwao Sugai (System Sciences Corp., Falls Church, Va.).
AIAA Journal, vol. 4, June 1966, p. 1108, 1109. 11 refs.
ARPA Contract No. SD-147.

Description of a few simple aspects of coverage area, a design parameter for Comsat systems. For simplicity, a spherical earth model of unit radius and Keplerian orbits are considered. A quadratic equation supplies the maximum instantaneous slant range for an earth station that is moving with the spherical cap of visibility. However, a possible application may be the prediction of the time of maximum Doppler frequency shift for the maximum slant range. It is noted that the rate of change of maximum slant range is not necessarily equal to the maximum rate of change of slant range. M.M.

A66-32692 #
SPACE APPLICATIONS - GROWING WORLDWIDE SYSTEMS.
Leonard Jaffe (NASA, Office of Space Science and Applications, Washington, D.C.).
Astronautics and Aeronautics, vol. 4, June 1966, p. 50-59.

Review of U.S. progress in the Space Applications Program. Accomplishments in communications, geodesy, meteorology, navigation and data collection, Applications Technology Satellites, and natural-resource surveys are surveyed. R.A.F.

A66-32900
DIRECT TV COMMUNICATIONS THROUGH SATELLITES? [DIREKTE FERNSEH-VERSORGUNG DURCH SATELLITEN?].
F. Vilbig.
DGRR, Mitteilungen, vol. 19, May 1966, p. 7-9. In German.

Consideration of the possibilities inherent in the application of satellites such as Telstar and Early Bird to establishing a global TV communications system. The geographical configuration required for establishing such a system is considered in terms of number of satellites, areas of the highest demographic density, and international standards for communications networks. D.P.F.

A66-32990
RADIATION PATTERN FOR ON-BOARD ANTENNAS OF COMMUNICATIONS SATELLITES [STRAHLUNGSDIAGRAMME FÜR BORD-ANTENNEN VON NACHRICHTENSATELLITEN].
Wolfgang Rebhan (Siemens und Halske AG, Zentrallaboratorium für Nachrichtentechnik, Munich, West Germany).
Frequenz, vol. 20, May 1966, p. 156-165. 5 refs. In German.
Research supported by the Bundesministerium für wissenschaftliche Forschung.

Method for the optimization of the radiation characteristics of antennas on board communications satellites which enables the greater part of the total transmitting power to be radiated toward the earth with a reasonably uniform distribution. Periodically changing distribution functions on a circular aperture are determined by means of which such radiation patterns can be produced. A comparison of such antennas with directional antennas that have a circular aperture with in-phase illumination shows that the radiation performance can be considerably improved for antennas carried by nonsynchronous satellites. Experimental results with simple models are presented. D. P. F.

A66-33783 #
SPACE BROADCASTING.
Robert P. Haviland (General Electric Co., Missile and Space Div., Valley Forge, Pa.).
Challenge, vol. 5, Summer 1966, p. 45-48.

Study of a new form of communication satellite, space broadcasting. It is noted that satellite broadcasting is not necessarily confined to television broadcasting. Other services such as the International Shortwave Service or the national high-fidelity FM service are possible. A discussion of problems at the listening end such as interference problems is made. Problems connected with the satellite such as the antenna size and problems of relative motion and of attitude control and lifetime are also discussed. The possibilities of space broadcasting are assessed. M. F.

A66-33848
EXPERIENCE WITH THE APPLICATIONS OF RADIO COMMAND GUIDANCE TO SATELLITE LAUNCH VEHICLES.
George H. Myers (Bell Telephone Laboratories, Inc., Whippany, N.J.).
IN: PEACEFUL USES OF AUTOMATION IN OUTER SPACE; INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL, SYMPOSIUM ON AUTOMATIC CONTROL IN THE PEACEFUL USES OF SPACE, 1ST, STAVANGER, NORWAY, JUNE 21-24, 1965, PROCEEDINGS. [A66-33845 18-31]
Edited by J. A. Aseltine.
New York, Plenum Press, 1966, p. 51-59; Discussion, p. 60.

The results of five years of experience in guiding satellites into orbit by means of radio command guidance are described. Some flight results from the Delta series, which includes the Tiros weather satellites, the Telstar, Relay, and Syncom communications satellites, and various other satellites and probes, are presented and discussed. The guidance system uses a single precision monopulse radar to measure missile position and transmits corrective orders and sequencing commands to the missile, using the beam as a communications channel. The missile-borne equipment acts only as a transponder and communications channel, which gives it a considerable weight advantage over inertial systems. As a result of this experience, suitable methods for adapting the control system to handle faults in input data and in the communications path to the missile, have been determined. In addition, efficient methods for controlling radar look-angles, for limiting missile bending moments during aerodynamic phases, and reducing range safety dispersions have been developed. These techniques are described, as well as the general methods used in applying a single guidance system and guidance computer program to such a diverse spectrum of satellite types. (Author)

A66-33854
CONTROL OF THE SYNCOM COMMUNICATION SATELLITE.
Donald D. Williams (Hughes Aircraft Co., Communications Satellite Laboratory, El Segundo, Calif.).
IN: PEACEFUL USES OF AUTOMATION IN OUTER SPACE; INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL, SYMPOSIUM ON AUTOMATIC CONTROL IN THE PEACEFUL USES OF SPACE, 1ST, STAVANGER, NORWAY, JUNE 21-24, 1965, PROCEEDINGS. [A66-33845 18-31]
Edited by J. A. Aseltine.
New York, Plenum Press, 1966, p. 132-140.

The spin-stabilized Syncom communication satellite is provided with a simple but versatile reaction control system for precession of the spin axis and correction of the orbit. The required control is achieved by use of two jets which may be pulsed on during a controlled sector of each spin revolution or operated continuously over many spin revolutions. The design requirements, configuration of the control system, and its operational use are described, and the in-orbit maneuvers of Syncom 2, the first synchronous satellite, and Syncom 3, the first stationary satellite, are summarized. (Author)

A66-34263 #
REQUIREMENTS FOR AERIAL MOUNTS FOR FOLLOWING SATELLITES.
D. H. Shinn (Marconi Co., Ltd., Chelmsford, Essex, England).
IN: CONFERENCE ON THE DESIGN AND CONSTRUCTION OF LARGE STEERABLE AERIALS, LONDON, ENGLAND, JUNE 6-8, 1966. [A66-34262 18-09]
Conference sponsored by the Electronics Division of the Institution of Electrical Engineers, the Institution of Electronic and Radio Engineers, the Institution of Mechanical Engineers, the Institution of Structural Engineers, and the United Kingdom and Eire Section of the Institute of Electrical and Electronics Engineers.
London, Institution of Electrical Engineers (IEE Conference Publication No. 21), 1966, p. 1-6.

Analysis of the problem of mounting an antenna to track a particular communications satellite. Land-borne and ship-borne antennas for tracking synchronous, subsynchronous, and other satellites are considered. R.A.F.

A66-34264 #
MULTIPLE ELEMENT AERIALS FOR SATELLITE EARTH STATIONS.
E. D. R. Shearman, D. E. N. Davies, and T. Pratt (Birmingham, University, Dept. of Electronic and Electrical Engineering, Birmingham, England).
IN: CONFERENCE ON THE DESIGN AND CONSTRUCTION OF LARGE STEERABLE AERIALS, LONDON, ENGLAND, JUNE 6-8, 1966. [A66-34262 18-09]
Conference sponsored by the Electronics Division of the Institution of Electrical Engineers, the Institution of Electronic and Radio Engineers, the Institution of Mechanical Engineers, the Institution of Structural Engineers, and the United Kingdom and Eire Section of the Institute of Electrical and Electronics Engineers.
London, Institution of Electrical Engineers (IEE Conference Publication No. 21), 1966, p. 7-11.

Consideration of the advisability of using a single earth-station antenna to communicate with several communications satellites. Three different types of system capable of forming several independent beams from one antenna aperture are discussed - a planar array with electronic beam steering; an array of small-aperture dishes, each with mechanical steering; and a fixed reflector system with multiple mechanically steered feeds. R.A.F.

A66-34271 #
PROPOSALS FOR A STEERABLE AERIAL FOR A SATELLITE COMMUNICATION EARTH STATION.
H. E. Pearson (General Post Office, Engineering Dept., London, England).
IN: CONFERENCE ON THE DESIGN AND CONSTRUCTION OF LARGE STEERABLE AERIALS, LONDON, ENGLAND, JUNE 6-8, 1966. [A66-34262 18-09]

Conference sponsored by the Electronics Division of the Institution of Electrical Engineers, the Institution of Electronic and Radio Engineers, the Institution of Mechanical Engineers, the Institution of Structural Engineers, and the United Kingdom and Eire Section of the Institute of Electrical and Electronics Engineers.
London, Institution of Electrical Engineers (IEE Conference Publication No. 21), 1966, p. 51-57.

Suggestion of a vertically fed, steerable, parabolic reflector system for the communications-satellite earth station at Goonhilly Downs. Both single- and dual-reflector systems are described.
R.A.F.

A66-35884
OPTIMUM LINK SCHEDULING IN SATELLITE COMMUNICATIONS SYSTEMS.
A. Kooharian and H. Young (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Applied Research Laboratory, Waltham, Mass.).
IN: RECENT ADVANCES IN OPTIMIZATION TECHNIQUES; PROCEEDINGS OF A SYMPOSIUM, CARNEGIE INSTITUTE OF TECHNOLOGY, PITTSBURGH, PA., APRIL 21-23, 1965. [A66-35867 19-08]
Symposium sponsored by the Systems Science and Cybernetics Group of the Institute of Electrical and Electronics Engineers, and the Optical Society of America.
Edited by Abrahim Lavi and T. P. Vogl.
New York, John Wiley and Sons, Inc., 1966, p. 559-572.
Research supported by Sylvania Electric Products; Contract No. AF 30(602)-2770.

Consideration of a system composed of a number of communications satellites distributed in nonsynchronous orbits and a set of communications stations on the earth. When a satellite is simultaneously in view of a pair (or link) of earth stations, a communication channel can be established between them through the satellite. The set of all possible regions of mutual satellite visibility defines the set of possible links which can be formed between earth stations, and a "communications system" is a selection of a set of these regions. The link scheduling problem can be formulated as an optimum control problem in which assignment decisions are made in time so as to optimally balance the cumulative value of communication time acquired on established links against the cumulative loss in communication time on those links forced to switch between satellites.
F.R.L.

A66-36047
FRANCE CAN DEVELOP A HEAVY BOOSTER - TWO APPROACHES ARE PROPOSED [LA FRANCE PEUT REALISER UN LANCEUR LOURD - DEUX FILIERES SONT PROPOSEES].
Jacques Morisset.
Air et Cosmos, vol. 4, June 25, 1966, p. 15-18. In French.

Description of French booster projects. These boosters may eventually orbit stationary communication satellites. Should the discussions on ELDO participation fail, it is thought that such projects may become necessary. The main projects discussed are those of SEREB (Diogene 2 with solid propellant first stages) and of LRBA (Vulcain with liquid propellant first stages). Weights of stationary satellites which may be orbited by these all-French boosters may be gradually increased from 120 lb to about 1200 lb.
F.R.L.

A66-36205 #
COMMUNICATIONS IN SPACE - EXISTING STRUCTURES AND FORESEEABLE PROBLEMS.
Andrew G. Haley (Haley, Bader and Potts, Washington, D.C.).
IN: COLLOQUIUM ON THE LAW OF OUTER SPACE, 8TH, ATHENS, GREECE, SEPTEMBER 14, 15, 1965, PROCEEDINGS. [A66-36201 19-34]
Colloquium sponsored by the International Institute of Space Law of the International Astronautical Federation.
Edited by A. G. Haley and M. D. Schwartz.
South Hackensack, N.J., Fred B. Rothman and Co., 1966, p. 34-99. 134 refs.

Detailed examination of the national and regional provisions for the commercial use of space satellites and a review of the activities related to the creation of a worldwide satellite communications system. Included also is a review of the creation of the Communications Satellite Corp. (COMSAT). Each of these developments is examined in detail and questions and problems growing out of these rapid changes in world communications technology organization are considered. It is hoped that this examination will encourage legislators, jurists, and lawyers in every nation to solve satellite communications problems. The role of the President in the formation of COMSAT is evaluated, as is that of the FCC, Securities and Exchange Commission, State Dept., etc. The Interim Communications Satellite Committee is extensively discussed.
M.L.

A66-36210 #
THE COMMUNICATIONS SATELLITE CORPORATION - THE BEGINNING OF A COMMERCIAL ERA IN SPACE.
William A. Hyman.
IN: COLLOQUIUM ON THE LAW OF OUTER SPACE, 8TH, ATHENS, GREECE, SEPTEMBER 14, 15, 1965, PROCEEDINGS. [A66-36201 19-34]
Colloquium sponsored by the International Institute of Space Law of the International Astronautical Federation.
Edited by A. G. Haley and M. D. Schwartz.
South Hackensack, N.J., Fred B. Rothman and Co., 1966, p. 183-199. 25 refs.

Detailed review of the circumstances of formation, initially set goals, operation features, and prospects of the Communications Satellite Corp. (COMSAT). A short history of the program is given, and the eight points of President Kennedy's statement concerning the corporation are summarized. The role congressional action played is discussed. The general characteristics of the corporation are considered. The various relations between the corporation and the Interim Communications Satellite Committee, other countries, the FCC, and NASA are examined. Particular attention is devoted to the statement that nondiscriminatory use of and equitable access to the system by authorized communications carriers are to be provided.
M.L.

A66-36229 #
COMMUNICATION SATELLITES - DIVIDING OR UNIFYING ELEMENTS [SATELLITES DE COMMUNICATION - ELEMENTS DE DISSIDENCE OU DE RAPPROCHEMENT].
Marco G. Marcoff.
IN: COLLOQUIUM ON THE LAW OF OUTER SPACE, 8TH, ATHENS, GREECE, SEPTEMBER 14, 15, 1965, PROCEEDINGS. [A66-36201 19-34]
Colloquium sponsored by the International Institute of Space Law of the International Astronautical Federation.
Edited by A. G. Haley and M. D. Schwartz.
South Hackensack, N.J., Fred B. Rothman and Co., 1966, p. 456-463. 14 refs. In French.

Survey of the objections of the Iron Curtain Countries to the COMSATCO. As an introduction, the possible uses of communication satellites are reviewed. The COMSATCO is seen as contradictory to the principles of the Declaration of 1962 of the UN.
M.L.

A66-36619
A METHOD FOR DETERMINING THE ACQUISITION AND CONTACT CHARACTERISTICS BETWEEN TRACKING STATIONS AND SATELLITES IN GENERAL ELLIPTIC ORBITS.
K. J. Ball and G. F. Osborne (Westland Aircraft, Ltd., East Cowes, Isle of Wight, England).
British Interplanetary Society, Journal, vol. 20, Nov.-Dec. 1965, p. 161-167.

For artificial earth satellites, and particularly for communication satellite systems, preknowledge of the visibility for a given network of ground stations is desirable. Furthermore, it is necessary to know the time at which the ground station equipment must be made operative and in which direction it must be orientated in order to contact the satellite as it appears on the horizon. In this paper, expressions derived, for any elliptic or circular orbit, include those for the acquisition time, azimuth of the satellite, and duration of contact for any ground station. Also included are expressions for the mutual contact time for two or more ground stations via the satellite. Although the initial results obtained are based on the assumption of a stationary earth, a simple iterative process is developed to include the effect of the rotation of the earth. By way of illustration, the method has been applied to the orbits of the Relay 1 and Telstar 1 communication satellites.
(Author)

A66-36897
MULTIPLE-ACCESS CONSIDERATIONS FOR COMMUNICATION SATELLITES.
F. Assadourian and D. L. Jacoby (Radio Corporation of America, Defense Electronic Products, Communications Systems Div., New York, N.Y.).
(Institute of Electrical and Electronics Engineers, Conference on Military Electronics, 9th, Washington, D.C., Sept. 22-24, 1965, Paper.)
RCA Review, vol. 27, June 1966, p. 179-198.

This paper discusses special aspects of multiple access for communication satellites. The major classes of multiple-access systems and their characteristics are briefly reviewed, and a system design philosophy is presented for those systems that share satellite power, i.e., frequency-division and spread-spectrum systems. A practical method is described for establishing nominal design values of satellite sharing factors and transmitter power in terms of other ground and satellite parameters and volume of traffic per link. Power level control is discussed in theoretical terms for the frequency-division multiplex (FDM) and spread-spectrum modes of multiple access. Up- and downleg path-loss calculations for the simultaneous links lead to a set of generally nonlinear equations, with ground effective-radiated power (ERP) levels as unknowns. Simplifications are possible when the satellite noise is negligible compared to the communication signals entering the satellite. Graphical procedures may then be used to obtain approximate solutions. Power-control dynamic ranges are also discussed. The final section discusses power-level control techniques that employ pilot signals emanating from ground stations, reference tones inserted at satellite repeaters, and comparative measurements of their returns to ground points. Centralized measurements, decentralized measurements, and programed approaches are all considered. (Author)

A66-37234
GLOBAL AERONAUTICAL COMMUNICATIONS WITH VHF.
R. R. Bohannon (Pan American World Airways, Inc., Miami, Fla.).
(Institute of Electrical and Electronics Engineers, Aerospace Systems Conference, Seattle, Wash., July 11-15, 1966, Paper.)
IEEE Transactions on Aerospace and Electronic Systems, Supplement, vol. AES-2, July 1966, p. 700-702.

Discussion of communications between the pilot and the ground controller, or between the pilot and a radio operator who relays information to a ground controller. On the New York to London route, vhf and hf communication bands are used. Solid vhf coverage exists along the track about 300 mi into the ocean on both the European and North American sides. Some limitations of hf systems, which must be used beyond these limits, are briefly described. A synchronous satellite vhf communications system is discussed in general terms. Such a system extends vhf range to 8000 miles. Eventually, an operational system using three satellites could replace hf as the long-range communications medium. F.R.L.

A66-37235
VHF AIRCRAFT ANTENNAS FOR COMMUNICATIONS VIA SYNCHRONOUS SATELLITE.
M. W. Alnutt and C. H. King (Boeing Co., Seattle, Wash.).
(Institute of Electrical and Electronics Engineers, Aerospace Systems Conference, Seattle, Wash., July 11-15, 1966, Paper.)
IEEE Transactions on Aerospace and Electronic Systems, Supplement, vol. AES-2, July 1966, p. 703-710. 10 refs.

Description of several special aircraft antennas developed for a series of propagation and communications tests. The experimental reception of vhf signals from a synchronous satellite on board a light aircraft is described. Nose radome yagi and window cavity arrays are discussed in terms of obtainable performances. It was found that omnioverhead coverage requirements can be met by a design combining a vertical monopole and crossed horizontal dipoles. D.P.F.

A66-37718
GROUND ANTENNAS FOR SPACE COMMUNICATION.
Tetsuo Sasaki (Kokusai Denshin Denwa Co., Ltd., KDD Laboratories, Communication Research Div., Radio Section, Tokyo, Japan) and Hiroshi Uda (Ministry of Posts and Telecommunications, Radio Research Laboratories, Tokyo, Japan).
Electronics and Communications in Japan, vol. 48, Apr. 1965, p. 132-146. 18 refs. Translation.

Description of the structure and performance of Japanese ground antennas for use with the communications satellites Telstar, Relay, and Syncom. Two antennas, one of 20-m diam, the other of 30-m diam, are described. Both are Cassegrain antennas rotatable in azimuth and elevation angle. The 30-m-diam antenna is intended for transmission and reception via the Relay satellite and for reception via Syncom. It is capable of tracking while operating with Relay. The 20-m-diam antenna was originally intended for transmission and reception in Telstar. Subsequently, it has also been used for transmission and reception with Relay. Switching from one to the other is accomplished in a few hours by replacing some of the feed horns and waveguides. M.M.

A66-37839 #
PHOTOMETRY OF ARTIFICIAL EARTH SATELLITES.
Władysław Naskręcki (Obserwatorium Astronomiczne, Poznań, Poland).
(Symposium on the Use of Satellite Observations, Kraków, Poland, Apr. 26-28, 1965, Paper.)
Artificial Satellites, vol. 2, Mar. 1966, p. 37-39.

Description of a photoelectric photometer to be used for tracking the entry of artificial satellites into the shadow of the earth. Satellites of the Echo type, because of their low angular velocity and great brightness, are considered particularly suitable for tracking. At present the photometer measures the integral brightness, but after slight changes are made, it will be suitable for measurements of brightness in several spectral bands. M.M.

A66-37842 #
ADJUSTMENT OF STELLAR TRIANGULATION AND ANALYSIS OF RESULTS.
Weneda Dobaczewska (Warszawa, Politechnika, Katedra Wyższej Geodezji, Warsaw, Poland) and Włodzimierz Baran (Wyższa Szkoła Rolnicza, Olsztyn, Poland).
(Symposium on the Use of Satellite Observations, Kraków, Poland, Apr. 26-28, 1965, Paper.)
Artificial Satellites, vol. 2, Mar. 1966, p. 58-69.

Description of the method of closing directions used in the adjustment of satellite triangulations performed on the basis of results of synchronous observations of Echo I during the spring of 1963. A total of 123 synchronous observations made at various stations was used. A preliminary analysis of the observational data showed that the position of the satellite was observed simultaneously from four points only in two cases, from three points in 17 cases, and from two points in 82 cases constituting 78% of the entire number of observations. The method of closing directions was selected over the classical method of intermediate observations. The results obtained confirmed that the observational errors of the individual stations are, in reality, several times greater than those accepted in the beginning of the adjustment. M.M.

A66-37843 #
RESULTS OF APPLYING THE TETRAHEDRON METHOD FOR SYNCHRONOUS OBSERVATIONS OF ECHO I MADE DURING MAY AND JUNE 1963.
Wojciech Pachelski (Polska Akademia Nauk, Centrum Obliczeniowe, Warsaw, Poland) and Janusz Zieliński (Warszawa, Politechnika, Katedra Geodezji Astronomii, Warsaw, Poland).
(Symposium on the Use of Satellite Observations, Kraków, Poland, Apr. 26-28, 1965, Paper.)
Artificial Satellites, vol. 2, Mar. 1966, p. 70-75.

Description of results of synchronous observations from three pairs of stations using the tetrahedron method. The results of the observations are tabulated, and the computed lengths or orbit chords are given. The mean values of coordinates and lengths of vectors found by solving each of the tetrahedrons indicated are tabulated together with their mean errors and the mean errors of individual observations. For comparison, coordinates and lengths of vectors calculated from geodetic coordinates referred to the Hayford ellipsoid are given. The results obtained confirm the conclusions of the theoretical analysis and of the testing computations on the accuracy of a particular segment. M. M.

A66-38425
TELEVISION SERVICE FOR LARGE AREAS USING SATELLITES [FERNSEHVERSORGUNG GROSSER GEBIETE DURCH SATELLITEN].
H. Strehl and A. Fiedler (Siemens und Halske AG, Zentrallaboratorium für Nachrichtentechnik, Munich, West Germany).
Frequenz, vol. 20, July 1966, p. 222-233. 7 refs. In German.

Discussion of the possibility of supplying Europe and other large areas with TV programs relayed by satellites assuming that centralized antenna systems be used for transmission and reception and that individual receivers be equipped with an additional low-power tunnel diode stage. In order to make TV coverage over large areas feasible, the transmitting power in satellites in synchronous orbits would have to be increased by only a few kw; these modifications could be realized within a few years. D. P. F.

A66-38864 #
GUIDANCE SIMULATION FOR POSITIONING OF SPIN STABILIZED COMMUNICATION SATELLITES.
J. P. O'Malley and D. H. Newell (TRW, Inc., TRW Systems Group, Redondo Beach, Calif.).
IN: AIAA/JACC GUIDANCE AND CONTROL CONFERENCE, SEATTLE, WASH., AUGUST 15-17, 1966. TECHNICAL PAPERS. [A66-38838 21-21]
New York, American Institute of Aeronautics and Astronautics, 1966, p. 304-312. 9 refs.
Research supported by the Centre National d'Etudes des Télécommunications.

The guidance equations for positioning a spin stabilized satellite in a circular orbit are derived. A positioning time constraint is considered requiring a capability for changing the orbit period after initial placement in orbit. This capability is provided by a velocity adjustment directed along the local velocity vector following an integral number of orbit revolutions. When the satellite has drifted to the proper position, a braking maneuver changes the period to the desired value, and a subsequent velocity correction removes the eccentricity. The operation assumes that the satellite spin axis lies in the plane of the orbit with a fixed inertial orientation. All velocity adjustments are parallel or antiparallel to the spin axis. Although the error propagation equations are assumed linear, the guidance equations relating the initial deviations, the points on the orbit at which corrections are executed, and the magnitudes of the adjustments are all nonlinear. Consequently, a Monte Carlo simulation was performed in order to determine the probability distributions for the summed magnitudes of the velocity adjustments. The results of the simulation were compared with approximate analytical estimates of the velocity requirements for a satellite which could execute tangential corrections at any point on the orbit. It was found that the use of spin stabilization requires approximately three times the summed velocity magnitudes required for positioning using tangential corrections. (Author)

A66-39694 #
DETERMINATION OF THE AZIMUTH POTSDAM-BUCHAREST FROM OBSERVATIONS OF THE ECHO I SATELLITE [DIE BESTIMMUNG DES AZIMUTES POTSDAM-BUKAREST AUS BEOBACHTUNGEN DES SATELLITEN ECHO I].
Kurt Arnold and Dietrich Schoeps.
Berlin, Akademie-Verlag (Veröffentlichungen des Geodätischen Instituts in Potsdam, no. 29), 1965. 28 p. In German.
$2.70.

Discussion of the work performed to determine the spatial direction, in particular the azimuth, of the connecting line between Potsdam and Bucharest from photographs of Echo I made between June 4 and 13, 1963. The theoretical foundations of the techniques used in the processing of the photographs and the determination of the space vector between the observation stations are outlined. The accuracy of the results obtained is seen to indicate the possibility of creating a world-wide grid in a system of absolute space coordinates. V. P.

A66-39856 #
PHOTOELECTRIC PHOTOMETRY OF ECHO II. I - METHOD OF MEASUREMENTS AND THEIR RESULTS [PHOTOMETRIE PHOTOELECTRIQUE DE L'ECHO II. I - METHODE DE MESURES ET LEURS RESULTATS].
F. Link and I. Zacharov (Czechoslovak Academy of Sciences, Astronomical Institute, Ondřejov, Czechoslovakia).
Astronomical Institutes of Czechoslovakia, Bulletin, vol. 17, no. 4, 1966, p. 151-160. 6 refs. In French.

Study of a method for photoelectric measurements and the light curves of Echo II. The photoelectric photometry of artificial satellites is discussed. The results of the measurements are presented in the form of light curves where the logarithms of the luminous intensity of the satellite in function of time are graphed. M. F.

A66-40068
THE EARLY BIRD PROJECT.
Martin J. Votaw (Communications Satellite Corp., Spacecraft Projects Div., Washington, D. C.).
(Institute of Electrical and Electronics Engineers, Northeast Electronic Research and Engineering Meeting, Boston, Mass., Nov. 3-5, 1965, Paper.)
IEEE Transactions on Communication Technology, vol. COM-14, Aug. 1966, p. 507-511.

Description of the design and performance of the Early Bird communications satellite which is a commercial venture owned by a consortium of 52 countries. The system uses one spin stabilized synchronous satellite and five earth stations to provide a full-time microwave link between North America and Europe for 240 telephone circuits or for television. The 85-lb spacecraft was launched from Cape Kennedy on Apr. 6, 1965, by NASA, using Thrust Augmented Delta Number 30. The launch sequence and subsequent maneuvers resulted in a circular synchronous orbit requiring no correction for seven months. The operational experience gained with this experimental/operational system has demonstrated satisfactory spacecraft performance characteristics and proven that synchronous communication satellites provide high quality links for telephone service. M. F.

A66-40176
SYNCHRONOUS COMMUNICATION SATELLITES OF THE MOON.
Dean Jamison (Stanford University, Stanford, Calif.).
IEEE, Proceedings, vol. 54, July 1966, p. 1000.

Application of the Lagrange libration points in the plane of revolution of two mutually gravitating heavy masses to the theory of synchronous communication satellites of the moon. It is shown how astronauts on the near or far side of the moon could communicate with each other with the aid of libration-point satellites of the moon and how continuous communication could be maintained with a radio-astronomy observatory located on the far side of the moon. It is pointed out that a libration-point satellite should not stray more than 7° from its nominal position, since the moon's orbital plane is inclined $6^{\circ}40'$ to its equator and the moon's orbit is slightly eccentric. A. B. K.

A66-40324
A PRECISION ELECTRONIC NAVIGATION SYSTEM USING OMEGA AND A SYNCHRONOUS SATELLITE NETWORK.
Charles Samek (Bell Telephone Laboratories, Inc., Murray Hill, N.J.) and Harold S. Pike (Nytronics, Inc., Berkeley Heights, N.J.).
Navigation, vol. 13, Summer 1966, p. 105-110.

Description of a simple and inexpensive - yet precise - electronic navigation system for marine use. The system known as OPLE (for OMEGA Position Locating Equipment), now being implemented by NASA, will use a communications satellite as a data relay link. The locations of the eight transmitting stations are indicated, and the proposed transmitted and received OMEGA signal formats are charted. Since OMEGA signals can be received at depths of 50 ft in the ocean, the system is considered to be applicable to Polaris submarine navigation. D.H.

A66-40699 #
SPACE COMMUNICATIONS - A POINTER TO THE FUTURE.
J. M. Brown (Marconi Co., Ltd., Space Communications Div., Chelmsford, Essex, England).
Point to Point Telecommunications, vol. 10, Oct. 1966, p. 4-20.

Discussion of satellite applications for long-distance communications, their effect on traditional methods, and the organization of the global communication system. The subjects of broadcasting, navigation, meteorology, defense, reconnaissance, and data transmission are also considered. M.M.

A66-40710
COMSAT OPERATIONS CENTER FOR THE INTERNATIONAL TELECOMMUNICATIONS SATELLITES.
George D. Dill (Communications Satellite Corp., Washington, D.C.).
IN: WESCON/66; WESTERN ELECTRONIC SHOW AND CONVENTION, LOS ANGELES, CALIF., AUGUST 23-26, 1966. TECHNICAL PAPERS. SESSION 4 - SATELLITE COMMUNICATIONS. [A66-40709 22-07]
Los Angeles, Western Electronic Manufacturers Association, 1966. 7 p.

Description of the operations philosophy and facilities required for the support of three International Telecommunications Satellites (INTELSATs) under the direction of the Comsat Operations Center. The system operations philosophy discussed includes operations coordination, operations activity, communications, information flow, performance analysis, and satellite launch and in-orbit command. INTELSAT I and INTELSAT II operations are described Brief design descriptions of the various systems making up the Comsat Operations Center are also included. M.F.

A66-40964
COVERAGE AND OVERLAP OF SATELLITES IN CIRCULAR EQUATORIAL ORBITS.
S. G. Lutz (Hughes Aircraft Co., Research Laboratories, Malibu, Calif.) and G. Dorosheski.
Institution of Electrical Engineers, Proceedings, vol. 113, Sept. 1966, p. 1495-1503. 5 refs.

Consideration of the earth areas within which many stations, all using the same satellite, can have multiple-access intercommunication without interruptions. These areas are the effective earth coverage in the case of a stationary satellite, or the coverage overlap at handover in the case of systems in single earth-track, medium-altitude, circular, equatorial orbits. An equation is derived for the overlap of the coverage areas of two satellites at equal heights, for given angular separation and given minimum angle above the earth's horizon. Families of coverage and overlap curves are given, and the relations between coverage and the earlier mutual-visibility area are explained. Diagrams of the boundaries of one-hop multiple-access systems, as viewed from above the pole, are shown and discussed, both for a six-satellite stationary-orbit system and for a 12-satellite 14,000-km phased system in circular equatorial orbit; these are used and compared in discussing routing principles. M.M.

A66-41142
COMMUNICATION SATELLITE SYSTEMS - SECOND GENERATION COMING UP.
George J. Vlay (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Waltham, Mass.).
Signal, vol. 21, Sept. 1966, p. 8-10.

Discussion of the coming generation of communication satellites which will be initiated with the launching of experimental satellites in 1967. Significant increases in radiated power can be achieved in spin-stabilized satellites by orienting the beam toward earth with phase shifters controlling a ring array of probes feeding a flared horn antenna. A flight model of an electronically despun antenna, which provides approximately an order of magnitude of radiated power increase for a spin-stabilized satellite, in the stage of being built, is shown. M.M.

A66-41590 #
ADAPTIVE FILTER DESIGN FOR OPTIMUM DETECTION OF SIGNALS IN NONSTATIONARY CHANNELS.
R. E. Nabours, D. G. Schultz, and A. N. Perkins.
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, 1966 REGION SIX ANNUAL CONFERENCE, TUCSON, ARIZ., APRIL 26-28, 1966, PAPERS. VOLUME 1. [A66-41580 23-07]
Edited by A. J. Hoehn.
Tucson, Ariz., Conference Record Committee, 1966, p. 166-177. 14 refs.

Practical design of time varying adaptive filter structures to provide a minimum mean square estimate of the signal in nonstationary channels, with reference to communication satellites. An engineering solution to the problem is presented, based upon an assumption of "quasi-stationarity" of the short-time power spectral densities of signal and noise. A recent control system approach is used to simplify the analytical solution of a set of equivalent Wiener problems, along with a linearization of the input power spectral density function by the asymptotic Bode technique which yields a measurement procedure for determining the nonstationary channel statistics. An analysis is performed to place in evidence the channel identification time requirements for optimum adaptive action of the time-varying filter. Two examples are simulated by analog techniques. F.R.L.

A66-41597 #
ELECTROMAGNETIC COMPATIBILITY OF FUTURE MILITARY SATELLITE AND GROUND-BASED SYSTEMS OPERATING IN THE SAME FREQUENCY BAND.
J. L. Levatich (Communications Satellite Corp., Washington, D.C.).
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, 1966 REGION SIX ANNUAL CONFERENCE, TUCSON, ARIZ., APRIL 26-28, 1966, PAPERS. VOLUME 1. [A66-41580 23-07]
Edited by A. J. Hoehn.
Tucson, Ariz., Conference Record Committee, 1966, p. 228-233. 6 refs.

Investigation of electromagnetic compatibility among communications satellites, tropospheric scatter, and line-of-sight (LOS) microwave systems operating in the same military frequency band. The conclusion that electromagnetic compatibility can be achieved is predicated on the basic assumptions and on careful system planning and equipment design. Satellite space segment and LOS microwave systems can coexist without any mutual interference. The space segment and tropospheric ground terminals can become incompatible if a spacecraft is in the main beam of a tropospheric terminal operating on the same carrier frequency. Electromagnetic compatibility between satellite, ground, tropospheric, and LOS terminals can be achieved by providing sufficient spatial separation between them to provide the required path loss. This distance depends on many variables and can range from thousands of feet to hundreds of miles. F.R.L.

A66-42635
MULTIPLE LARGE-SIGNAL THEORY FOR A TWT.
A. J. Giarola and G. B. Coughlan (Boeing Co., Aerospace Group, Missile and Information Systems Div., Seattle, Wash.).
IEEE, Proceedings, vol. 54, Sept. 1966, p. 1215, 1216.

Outline of a new multiple large-signal theory for traveling-wave tube amplifiers (TWTs) which uses assumptions that are more restrictive than those of El-Shandwily but gives accuracies that are sufficient for most practical problems with reasonable amounts of computer time. The major assumptions are the same as those made by El-Shandwily, but five additional assumptions are made: (1) the circuit is loss-free, (2) only frequencies with an octave band are allowed to grow in the tube, (3) signals of interest have frequency separations larger than a minimum time, (4) but which are close enough so that it is possible to assume that the phase velocities and impedances of the waves in the tubes and the tube parameters are independent of frequency, and (5) all signals present in the TWT are multiples of a base frequency, which is chosen smaller than the minimum allowed frequency spacing between signals. M. L.

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A67-10207
SATELLITE REPEATER SYSTEM FOR ADVANCED AIRCRAFT/GROUND COMMUNICATIONS.
J. J. Sparagna and D. F. McClinton (Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Sunnyvale, Calif.).
IEEE Transactions on Vehicular Communications, vol. VC-15, Oct. 1966, p. 1-7. 9 refs.

The paper considers the application of satellite relay techniques to provide communication paths for aircraft-ground communication over the ocean. It considers the feasibility of a communication system design for air traffic control (ATC) utilizing the reflex repeater as the basic satellite-borne relay device. Implementation of satellite relay techniques would permit continuous line-of-sight operation for reliable ATC digital data links and voice transmission. The paper describes the basic use of the relay system, the repeater electronics, and the communication link parameters required to accommodate the satellite-aircraft link geometries. Examples of typical aircraft-ground link calculations are presented, and the basic supersonic aircraft communication requirements and satellite contact profiles are discussed. (Author)

A67-10452 #
COMMUNICATIONS VIA SATELLITES [NACHRICHTENVERBINDUNGEN ÜBER SATELLITEN].
Herbert Rosen (TRW, Inc., TRW Systems Group, Redondo Beach, Calif.).
Weltraumfahrt Raketentechnik, vol. 17, no. 3A, 1966, p. 103-106. In German.

Discussion of the Early Bird and the Thompson-Ramo-Wooldridge systems and their use in world-wide communications. The impact of communications satellites on military, technological, economical, and political aspects of modern society is outlined. V.P.

A67-10453 #
COMMUNICATIONS VIA EARLY BIRD [NACHRICHTENÜBERTRAGUNG ÜBER EARLY BIRD].
Robert Uhlitzsch (Deutsche Bundespost, Erdefunkstelle, Raisting, West Germany).
Weltraumfahrt Raketentechnik, vol. 17, no. 3A, 1966, p. 107, 108, 110-112. In German.

Discussion of the tasks and problems of a ground signal station on the example of the Early Bird satellite and the Raisting station in Oberbayern, Germany. The communications capacity data of Early Bird are tabulated. The characteristics of a planned world-wide synchronous-satellite communications system are predicted. V.P.

A67-10454 #
ELDO LAUNCHING ROCKETS FOR COMMUNICATIONS SATELLITES [ELDO-TRÄGERRAKETEN FÜR NACHRICHTENSATELLITEN].
G. K. C. Pardoe and L. W. Steines (Hawker Siddeley Dynamics, Ltd., Hatfield, Herts., England).
Weltraumfahrt Raketentechnik, vol. 17, no. 3A, 1966, p. 113, 114, 116. In German.

Discussion of capabilities of the ELDO booster to launch a European communications satellite. It is seen that the special apogee and perigee stages, in the form of small solid-propellant rockets carried by the payload, are well suited to achieve the type of circular orbit required by communications satellites. It is found that the upper limit of the ELDO rocket capability is to place a 150-kg mass into an equatorial orbit. V.P.

A67-11343
SPACECRAFT COMPONENT RELIABILITY.
C. M. Ryerson (Hughes Aircraft Co., Culver City, Calif.).
IN: 1966 ANNUAL SYMPOSIUM ON RELIABILITY, SAN FRANCISCO, CALIF., JANUARY 25-27, 1966, PROCEEDINGS. [A67-11332 01-15]
Symposium sponsored by the Institute of Electrical and Electronics Engineers, the Institute of Environmental Sciences, the Society for Nondestructive Testing, and the American Society for Quality Control.
New York, Institute of Electrical and Electronics Engineers, 1966, p. 173-179.

Condensation of the component experience on the Syncom, Early Bird, ATS satellites, and the Surveyor spacecraft. Component reliability screening techniques are reviewed and explained. The special application of degradation analysis is described, and examples of its use included. It is concluded that 100% power-aging for extended time periods with degradation analysis of trends in the value of critical indicator parameters is a valuable tool. It is pointed out that all the parts rejected on the Early Bird project for incipient unreliability were still well within the normal quality acceptance criteria. M. L.

A67-11418 #
POSITIONING OF A EUROPEAN SYNCHRONOUS SATELLITE BY THE ELDO-A BOOSTER [MISE A POSTE D'UN SATELLITE GEOSTATIONNAIRE EUROPEEN PAR LE LANCEUR ELDO A].
B. Dorléac, J. C. Poggi, and J. Lauroua (Société pour l'Etude et la Réalisation d'Engins Balistiques, S. A., Courbevoie, Seine, France).
International Astronautical Federation, International Astronautical Congress, 17th, Madrid, Spain, Oct. 9-15, 1966, Paper. 34 p. In French.

Discussion of the possibilities of placing a satellite with a mass of 150 kg in a synchronous orbit by means of the ELDO PAS booster, a development of the ELDO-A. The ELDO PAS is provided with a perigee thrustor and an apogee thrustor and the necessary equipment for this method of orbiting. It is to be fired from a near-equatorial base in Guiana, and the satellite is intended for telecommunications purposes. The PAS could be developed within three years, thus putting a suitable booster at the disposition of the European nations. F. R. L.

A67-12306
AIRCRAFT/SATELLITE COMMUNICATION RELAY.
Gerald T. Bergemann and Howard L. Kucera (Collins Radio Co., Aviation and Applied Sciences Div., Dallas, Tex.).
Signal, vol. 14, Fall 1966, p. 24-26.

Discussion of the problems related to communication relay to aircraft by satellite. Some typical calculated values, given for the satellite-to-aircraft spatial standing wave pattern produced by interference between direct waves and reflected waves, are illustrated and discussed. Values are given that are typical of the selective fade patterns to be expected at various separations of the subsatellite and subaircraft points and various aircraft altitudes; values representing fading depth as a function of the distance between the subsatellite and subaircraft points are plotted. The antenna gain and other characteristics of the ATS-B satellite are discussed, along with future plans for using it as part of a test facility. B.B.

A67-12832
IONOSPHERIC STUDIES USING THE TRACKING BEACON ON THE "EARLY BIRD" SYNCHRONOUS SATELLITE.
J. R. Koster (Ghana, University, Legon, Ghana).
(International Symposium on Equatorial Aeronomy, 2nd, São José dos Campos, São Paulo, Brazil, Sept. 6-17, 1965, Paper.)
Annales de Géophysique, vol. 22, July-Sept. 1966, p. 435-439.
Contract No. AF 61(052)-800.

Continuous observations over a period of 81 days were made of the 136-Mc signal radiated by Early Bird. During times of scintillation, three stations with a maximum spacing of 21 km were used. Results include information on the diurnal variation of total electron content, and new information on equatorial scintillation and the irregularities giving rise to it. (Author)

A67-12898
DATA TRANSMISSION WITH EARTH SATELLITES [NACHRICHTEN-ÜBERTRAGUNG MIT KÜNSTLICHEN ERDSATELLITEN].
Rudolf Trachsel (PTT-Betriebe, Linienabteilung, Sektion Planung, Bern, Switzerland).
Sciences et Industries Spatiales, vol. 2, no. 9-10, 1966, p. 45-50.
In German.

Description of the technical properties of the first commercial communications satellite (Early Bird; Intelsat), a synchronous satellite which has mainly been designed for the transmission of telephone signals. The launching operation, the positioning of the satellite, its economic aspects, and the present organization for the establishment and operation of satellite communications systems are described. The program for the extension of a worldwide satellite communications system in the next few years is outlined. The problem of ground stations in Europe is examined. F.R.L.

A67-12967
SPACE RESEARCH AND AEROSPACE ENGINEERING IN THE EUROPEAN COOPERATION [WELTRAUMFORSCHUNG UND RAUMFLUGTECHNIK IN DER EUROPÄISCHEN ZUSAMMENARBEIT].
Günther Bock (Darmstadt, Technische Hochschule, Institut für Flugtechnik, Darmstadt, West Germany).
(Wissenschaftliche Gesellschaft für Luft- und Raumfahrt, Europäischer Luftfahrtkongress, 6th, Munich, West Germany, Sept. 1-4, 1965, Paper.)
IN: YEARBOOK 1965; WISSENSCHAFTLICHE GESELLSCHAFT FÜR LUFT- UND RAUMFAHRT, EUROPEAN AERONAUTICAL CONGRESS, 6TH, MUNICH, WEST GERMANY, SEPTEMBER 1-4, 1965, REPORTS [JAHRBUCH 1965; WISSENSCHAFTLICHE GESELLSCHAFT FÜR LUFT- UND RAUMFAHRT, EUROPÄISCHER LUFTFAHRTKONGRESS, 6TH, MUNICH, WEST GERMANY, SEPTEMBER 1-4, 1965, VORTRÄGE]. [A67-12965 03-02]
Edited by Hermann Blenk.
Braunschweig, West Germany, Friedrich Vieweg und Sohn GmbH, 1966, p. 24-38. In German.

Discussion of the activity of the ESRO and ELDO organizations in the fields of space research and aerospace engineering. Particular attention is given to the planned European participation in a communications satellite system promoted by the U.S. Several national programs being developed for this purpose are reviewed. V.P.

A67-13105
POSITIONS OF ECHO 1, ECHO 2, AND A SATELLITE DURING THE REENTRY STAGE, OBSERVED AT ASIAGO IN 1964 [POSIZIONI DI ECHO I, DI ECHO II E DI UN SATELLITE IN FASE DI CADUTA, RILEVATE AD ASIAGO NEL 1964].
Augusto Mammano and Rodolfo Rigoni (Consiglio Nazionale delle Ricerche, Centro di Studio per l'Astrofisica, Osservatorio Astrofisico di Asiago, Rome, Italy).
Ricerca Scientifica, vol. 36, June 1966, p. 415-418. 6 refs.
In Italian.

Description of the results of photographic observations in 1964 of the Echo satellites (1960 Iota 1 and 1964-4A). An object observed on September 25, 1964, is tentatively identified with the satellite 1964-56B during its reentry into the atmosphere. M. M.

A67-13826
THE INITIAL DEFENSE COMMUNICATION SATELLITE.
Wilbur L. Pritchard (Aerospace Corp., El Segundo, Calif.).
Microwave Journal, vol. 9, Nov. 1966, p. 43-47.

Argument in support of the need for a separate military communications satellite. The initial defense communications satellite, in contrast to a commercial satellite, requires only a few channels which must, however, be global, as jam-resistant as possible, and available in even the gravest of circumstances, such as after a nuclear attack. It also meets the necessity for vital government messages to be carried independently of commercial traffic. The background of the present development program and the basic satellite design are described. The results of launching seven communication satellites and one special gravity-gradient experimental satellite are briefly discussed. S.Z.

A67-13830
SATELLITE COMMUNICATIONS SYSTEMS.
John M. Barstow (Communications Satellite Corp., Washington, D.C.).
(1966 Microwave Journal Seminar, New York, N.Y., 1966, Lecture.)
Microwave Journal, vol. 9, Nov. 1966, p. 100-102, 104, 105.

Review of the experience with Early Bird circuits and an outline of plans now under consideration which may result in an expansion of satellite communications in the next few years. Results of user reaction tests made so far have indicated that satisfactory telephone service can be provided with synchronous satellite links plus terrestrial extensions. Engineering studies have shown that global coverage by one-hop synchronous satellite circuits is possible using terrestrial extensions over areas having well developed communications systems. The number of synchronous satellites required depends on the magnitude of traffic and both satellite and earth station developments. In the next few years, three to five satellites, each having relay capabilities of 1200 or more two-way circuits, will very likely satisfy the telephone requirements. S.Z.

A67-14110 *
CONTINUOUS RECORDS OF THE TOTAL ELECTRON CONTENT OF THE IONOSPHERE.
J. E. Titheridge (Auckland, University, Radio Research Centre, Auckland, New Zealand).
Journal of Atmospheric and Terrestrial Physics, vol. 28, Dec. 1966, p. 1135-1150. 21 refs.
Grant No. NsG-54-60.

Description of equipment for automatic recording of the polarization angle of the 137-Mc signal from the geostationary satellite Syncom 3. Clear, unambiguous records are obtained from a weak signal, with a time resolution of about 10 sec. The records can be scaled to read directly in terms of the total electron content of the ionosphere (N_T). A long-term accuracy of better than 1% is easily obtained, while rapid changes of only 0.1% in N_T can be observed. Results obtained at Auckland from June 1965 to April 1966 are presented. The figures given agree with observations of the rate of change of the critical frequency, showing that the ionization decays at the same rate at all heights. S.Z.

A67-14240 #
VARIATION IN IONOSPHERIC ELECTRON CONTENT MEASURED BY RADIO WAVES FROM SYNCOM 3.
Yoshiaki Nakata (Ministry of Posts and Telecommunications, Radio Research Laboratories, Tokyo, Japan).
(Symposium on Radio Astronomical and Satellite Studies of the Atmosphere, 2nd, Boston, Mass., Oct. 19-21, 1965, Paper 1-10-129.)
Radio Science, vol. 1, Oct. 1966, p. 1145-1148. 5 refs.

Measurements of the Faraday rotation of a 136.98 Mc signal radiated from the geostationary satellite Syncom 3 is used to determine the time variation in the total electron content in the ionosphere. Good agreement of the time variation between the Faraday rotation and the square of f_0F_2 is found, and the slope of the line of this relationship is determined by the distribution of electron density at a particular height. Absolute values of total electron content are determined from the intercept on the ordinate intersected by this line. Good agreement is maintained not only on the quiet day, but also on the disturbed day. (Author)

A67-14241 #
MIDDLE-LATITUDE IONOSPHERIC TOTAL ELECTRON CONTENT - SUMMER 1965.
J. A. Klobuchar and H. E. Whitney (USAF, Office of Aerospace Research, Cambridge Research Laboratories, Bedford, Mass.).
(Symposium on Radio Astronomical and Satellite Studies of the Atmosphere, 2nd, Boston, Mass., Oct. 19-21, 1965, Paper 1-10-130.)
Radio Science, vol. 1, Oct. 1966, p. 1149-1154. 7 refs.

The total electron content of the ionosphere was measured continuously from a northern midlatitude station during the summer of 1965 by monitoring the polarization twist of vhf radio signals from the Early Bird synchronous satellite. The ambiguity in the total amount of polarization twist of the Early Bird signal was resolved by measuring the total polarization twist of a lunar reflected radio wave at a time when the moon coincided in direction with Early Bird. Large day-to-day differences in electron content were seen. The late afternoon maximum value of electron content was not well related to magnetic activity. Many small, irregular changes in electron content were observed. Diurnal values of electron content were much lower than those observed during 1961. Observations of polarization twist of vhf radio waves from synchronous satellites provide a simple, accurate means of measuring diurnal, seasonal, and anomalous changes in ionospheric total electron content. (Author)

A67-14242 #
IONOSPHERIC MEASUREMENTS BY MEANS OF THE EARLY BIRD GEOSTATIONARY SATELLITE.
P. F. Checcacci (Consiglio Nazionale delle Ricerche, Centro Microonde, Florence, Italy).
(Symposium on Radio Astronomical and Satellite Studies of the Atmosphere, 2nd, Boston, Mass., Oct. 19-21, 1965, Paper 1-10-131.)
Radio Science, vol. 1, Oct. 1966, p. 1154-1158. 7 refs.
Research supported by the Consiglio Nazionale delle Ricerche and NATO.

The vhf emission of the Early Bird geostationary satellite during the period June 23 to July 9, 1965, has been used for ionospheric measurements at Florence, Italy (43°48' N, 11°13' E). Electron content daily variation curves obtained from Faraday rotation measurements show a maximum-to-minimum ratio of about 5. The equivalent slab thickness ranges from 140 to 310 km. The scintillation occurrence shows maxima at night and at noon. (Author)

A67-15074
RANDOM TROPOSPHERIC ANGLE ERRORS IN MICROWAVE OBSERVATIONS OF THE EARLY BIRD SATELLITE.
J. H. W. Unger (Bell Telephone Laboratories, Inc., New York, N.Y.).
Bell System Technical Journal, vol. 45, Nov. 1966, p. 1439-1474. 21 refs.

A simplified analytical model of tropospheric random variations in angle measurements is described. This model is used to predict the minimum and maximum power density spectra between which the tropospheric random angle errors of observations on the Early Bird satellite are expected to lie. The apparent angular position of the Early Bird satellite was then measured at microwave frequencies with the large horn-reflector antenna at the station near Andover, Me. Random variations in the azimuth and elevation angles have been observed and recorded. The analysis of these records results in a description of the observed random angle variations by their power density spectra. A comparison of the predicted power density spectra from the model with the observed spectra is made. It is concluded that the observed random angle variations are indeed caused by random tropospheric refraction. The feasibility of acquiring data on atmospheric propagation effects, particularly tropospheric angle errors, with the aid of geostationary satellites is therefore also demonstrated. (Author)

A67-16568
PASSIVE SPIN PROPULSION OF LARGE FLEXIBLE SPHERICALLY SHAPED SATELLITES BY THE SOLAR RADIATION FIELD.
John Mar and Frank R. Vigneron (Defence Research Board, Defence Research Telecommunications Establishment, Ottawa, Canada).
IN: TRAJECTORIES OF ARTIFICIAL CELESTIAL BODIES; COSPAR, INTERNATIONAL ASTRONOMICAL UNION, AND INTERNATIONAL UNION OF THEORETICAL AND APPLIED MECHANICS, SYMPOSIUM, PARIS, FRANCE, APRIL 20-23, 1965, PROCEEDINGS. [A67-16554 05-30]
Edited by Jean Kovalevsky.
Berlin, Springer-Verlag, 1966, p. 151-163. 8 refs.

An analysis showing that a nonrigid spherically shaped orbiting body may undergo passive spin in the sun's electromagnetic and radiation pressure fields is proposed. The possibility of such an occurrence is illustrated by considering the spin behavior of Echo 2 satellite. (Author)

A67-16831 *
MAGNETIC ATTITUDE ACTUATION FOR PASSIVE SATELLITES.
Ants Kristiansen (Westinghouse Electric Corp., Atomic, Defense and Space Group, Aerospace Div., Magnetic Devices Section, Baltimore, Md.).
IEEE Transactions on Magnetics, vol. MAG-2, Dec. 1966, p. 733-738.
Contract No. NAS 1-3131.

Adjustment of the orientation of a passive communications satellite with respect to the earth by use of an electromagnetic actuator which is rigidly mounted on the structure of the satellite. The actuator consists of three mutually orthogonal air-cored coils on the skin of the satellite. If any one of the coils is excited by current, the magnetic field generated by it tends to rotate the satellite until the generated field and the terrestrial magnetic field are aligned. The activation of the coils also produces various undesirable forces which must be supported by the satellite structure. If the actuator is mounted on an ultrathin structure, these forces can have damaging effects. Equations are derived for the adjusting torque and for the undesirable forces. It is concluded that the compressive force on the coil loops caused by the terrestrial field poses the most serious danger to the satellite structure. F.R.L.

A67-17257
RELIABILITY SCREENING.
C. M. Ryerson (Hughes Aircraft Co., Culver City, Calif.).
IN: ANNUAL TECHNICAL CONFERENCE TRANSACTIONS 1966; AMERICAN SOCIETY FOR QUALITY CONTROL, ANNUAL TECHNICAL CONFERENCE, 20TH, NEW YORK, N. Y., JUNE 1-3, 1966, TRANSACTIONS. [A67-17240 05-15]
Milwaukee, American Society for Quality Control, Inc., 1966, p. 536-543.

Review of some new concepts of variability measurement which can become major reliability control tools on all future high reliability projects. Failure characteristics of part lots, quality vs reliability screening, selection of indicator parameters, and degradation analysis tests are discussed. The use of degradation analysis to screen for reliability all the parts used on the COMSAT "Early Bird" satellite is described. F.R.L.

A67-17556 ±
INTELSAT AND THE INTERNATIONAL CONSORTIUM FOR TELECOMMUNICATIONS BY SATELLITES [INTELSAT ET L'ORGANISATION MONDIALE DES TELECOMMUNICATIONS PAR SATELLITES].
Jean Voge (Bruxelles, Université Libre, Brussels, Belgium; Centre National d'Etudes des Télécommunications, Paris, France).
Sciences et Industries Spatiales, vol. 2, no. 11-12, 1966, p. 33-40. In French.

Discussion of the accomplishments and projects of Intelsat. The conditions influencing its creation in July 1964 are described. The 1965 launching of Early Bird (Intelsat 1) to afford telephone and television service over the North Atlantic is mentioned, as well as the launching of Intelsat 2. Future projects include the first world-spanning network to be set up in 1968, with satellites having a capacity of 1200 telephonic messages as compared to 240 for its predecessors. By 1972, Intelsat satellites should meet new requirements such as television distribution, aeronautical and maritime communications, and the collecting and broadcasting of various data one they have been processed. It is concluded that there seems to be some inconsistency between the principle of an international organization claiming a world monopoly and the control of that organization in practice by M.F.

A67-17560 #
BROADCASTING OF TELEVISION PROGRAMS BY SATELLITES [LA DIFFUSION DE PROGRAMMES DE TELEVISION PAR SATELLITES].
Jacques Chaumeron (Compagnie Française Thomson-Houston, Paris, France).
Sciences et Industries Spatiales, vol. 2, no. 11-12, 1966, p. 57-62. In French.

Discussion of the problems of broadcasting television by satellites. The appearance of a new generation of television-relay satellites, with transmissions that could be directly received by the public, is expected. These satellites must send out sufficient power so that the receiving apparatus on the ground may be simple and inexpensive. If the antenna beam is calculated to cover a fixed geographical zone, the power needed for the transmission is independent of the altitude of the satellite. This latter can therefore be stationary without affecting the power aspect unfavorably. An intermediate generation, that of the distribution satellites, is planned for the near future. M.F.

A67-17662
COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966.)
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966. 1051 p.
$12.

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AN ELECTRONICALLY DESPUN SWITCHED ANTENNA. John D. Kiesling and William S. Maco (Radio Corporation of America, Princeton, N.J.), p. 433-464. [See A67-17684 06-09]

GROUND-BASED ANTENNAS FOR SATELLITE COMMUNICATIONS. Allan C. Schell (USAF, Office of Aerospace Research, Bedford, Mass.), p. 465-480. 5 refs. [See A67-17685 06-09]

GAIN LIMITS OF ELECTRONICALLY DESPUN ANTENNAS FOR COMMUNICATION SATELLITES. Stephen N. Andre and Dennis J. Leonard (Sylvania Electric Products, Inc., Williamsville, N.Y.), p. 481-497. [See A67-17686 06-09]

HIGH-POWER SYSTEMS.

NUCLEAR POWER SYSTEMS FOR ADVANCED HIGH-POWERED COMMUNICATIONS SATELLITES. J. D. Gylfe (North American Aviation, Inc., Canoga Park, Calif.), p. 501-528. [See A67-17687 06-22]

HIGH-POWERED TRAVELING-WAVE TUBES FOR SPACE TRANSMITTERS. John T. Mendel (Hughes Aircraft Co., Los Angeles, Calif.), p. 529-548. [See A67-17688 06-09]

A DIRECT-TO-HOME TV SATELLITE SYSTEM FOR 1970. R. B. Marsten and S. Gubin (Radio Corporation of America, Princeton, N.J.), p. 549-571. [See A67-17689 06-31]

SELF-STEERING ARRAYS FOR SATELLITE APPLICATIONS. W. H. Kummer (Hughes Aircraft Co., Culver City, Calif.), p. 573-592. [See A67-17690 06-09]

EARTH STATIONS FOR RECEPTION OF TELEVISION SIGNALS FROM A STATIONARY SATELLITE. Donald M. Jansky and Charles E. Sampson (Atlantic Research Corp., Alexandria, Va.), p. 593-617. [See A67-17691 06-11]

REQUIRED AND ATTAINABLE INTERFERENCE RATIOS IN SPACE TELECASTING. R. P. Haviland (General Electric Co., Philadelphia, Pa.), p. 619-637. 16 refs. [See A67-17692 06-07]

SYSTEMS CONCEPTS - PRESENT AND FUTURE.

PARAMETRIC TRADEOFF ANALYSIS FOR COMSAT SYSTEM DESIGN. Robert J. W. Price (Technical Communications Corp., Lexington, Mass.), p. 641-666. 6 refs. [See A67-17693 06-07]

MULTIPLE-ACCESS MODULATION TECHNIQUES. D. T. Magill (Philco Corp., Palo Alto, Calif.), p. 667-680. 6 refs. [See A67-17694 06-07]

A COMMUNICATION SATELLITE SYSTEM FOR MANY USERS. R. S. Davies and J. M. Stephenson (Philco Corp., Palo Alto, Calif.), p. 681-694. [See A67-17695 05-07]

USE OF FREQUENCY-TIME CODED PULSED SIGNALS IN SATELLITE COMMUNICATIONS SYSTEMS. Herbert Koppel (Martin Marietta Corp., Orlando, Fla.), p. 695-712. 7 refs. [See A67-17696 06-07]

TV NETWORK SATELLITE SYSTEMS. Samuel Gubin and James J. Hawley (Radio Corporation of America, Princeton, N.J.), p. 713-733. [See A67-17697 06-07]

ESTABLISHMENT AND MAINTENANCE OF A COMMUNICATION SATELLITE SYSTEM. D. D. Werts (TRW, Inc., Redondo Beach, Calif.), p. 735-753. [See A67-17698 06-31]

SCHEDULING AND CONTROL OF SATELLITE COMMUNICATIONS SYSTEMS. Ward Ellis and Morton D. Lenske (Litton Industries, Inc., Sunnyvale, Calif.), p. 755-774. [See A67-17699 06-07]

GROUND AND SATELLITE TELECOMMUNICATIONS NETWORKS FOR GLOBAL INFORMATION SYSTEMS. James P. Rahilly (Philco Corp., Palo Alto, Calif.), p. 775-797. 22 refs. [See A67-17700 06-07]

AERONAUTICAL COMMUNICATION SATELLITES. John Jansen (TRW, Inc., Redondo Beach, Calif.), p. 799-818. [See A67-17701 06-07]

POST ECHO II PASSIVE COMMUNICATION SATELLITES AND SYSTEMS. Charles M. Kelly (Goodyear Aerospace Corp., Akron, Ohio), p. 819-846. 26 refs. [See A67-17702 06-07]

ORBIT POSITION CONTROL FOR PASSIVE COMMUNICATIONS SATELLITES. J. A. Miller, R. H. Laprade, and S. J. Worley (Westinghouse Electric Corp., Baltimore, Md.), p. 847-870. [See A67-17703 06-31]

SOME DESIGN CONSIDERATIONS FOR PLANETARY RELAY COMMUNICATIONS SATELLITES. Roger D. Bourke and Thomas A. Barber (California Institute of Technology, Pasadena, Calif.), p. 871-886. 7 refs. [See A67-17704 06-31]

LUNAR COMMUNICATION SATELLITES. George E. Neuner (TRW, Inc., Redondo Beach, Calif.), p. 887-908. 27 refs. [See A67-17705 06-07]

DEEP-SPACE OPTICAL COMMUNICATIONS. C. W. Chapoton and J. W. White (Westinghouse Electric Corp., Baltimore, Md.), p. 909-923. [See A67-17706 06-07]

SOCIOLOGICAL OVERVIEW.

PREFACE TO CHAPTER VI. Stephen E. Doyle, p. 927, 928.

ORGANIZATION AND PROGRAM OF INTELSAT. Edwin J. Istvan (Communications Satellite Corp., Washington, D.C.), p. 929-939. [See A67-17707 06-34]

BUSINESS FORECASTING FOR COMMUNICATION SATELLITE SYSTEMS. L. B. Early, L. Kumins (Communications Satellite Corp., Washington, D.C.), and J. Baer (Hughes Aircraft Co., Los Angeles, Calif.), p. 941-954. [See A67-17708 06-34]

FUTURE PATTERNS OF COMMUNICATION SATELLITE SYSTEMS. G. K. C. Pardoe and L. W. Steines (Hawker Siddeley Dynamics, Ltd., London, England), p. 955-981. [See A67-17709 06-07]

AN ECONOMETRIC ANALYSIS OF AN EDUCATIONAL TV DISTRIBUTION SYSTEM. R. F. Burnes, J. F. Delfico, S. Hauer, and W. R. Kestle (Hughes Aircraft Co., El Segundo, Calif.), p. 983-1009. [See A67-17710 06-34]

COMMUNICATIONS IN ORBIT - A LEGAL ANALYSIS AND PROGNOSIS. Jerome Morenoff (Planning Research Corp., Washington, D.C.), p. 1011-1031. 12 refs. [See A67-17711 06-34]

EUROPEAN PERSPECTIVES ON SATELLITE COMMUNICATIONS. Edmund W. Faller (Köln, Universität, Cologne, West Germany), p. 1033-1051.

A67-17663

EARLY BIRD PLACEMENT IN A STATIONARY ORBIT - LAUNCH AND CONTROL SYSTEM MANEUVERS.
Robert H. Greene (Wolf Research and Development Corp., Bladensburg, Md.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-262.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 9-42. 7 refs.

A67-17664

EARLY BIRD I COMMUNICATIONS PARAMETERS.
Simon B. Bennett (Communications Satellite Corp., Washington, D.C.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-263.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 43-57.

A67-17665

EXPERIMENTAL PERFORMANCE OF THE EARLY BIRD COMMUNICATION SYSTEM.
L. F. Gray (Communications Satellite Corp., Washington, D.C.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-264.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 59-75.

A67-17666
RESULTS OF USER REACTION TESTS ON COMMUNICATION VIA EARLY BIRD SATELLITE.
John M. Barstow (Communications Satellite Corp., Channel Utilization Dept., Washington, D.C.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 77-83.

Results of measurements of quality of communication via satellite and cable circuits by three different methods - (1) callback interviews, (2) service observations, and (3) circuit rejection counts. Contributions were obtained from the U.S. (with cooperation from the U.K., France, and Germany) together with independent findings from the U.K., Germany, Italy, and Scandinavia (Denmark, Norway, and Sweden). The three methods of measurement produced different results, the callback interviews apparently magnifying the effect of satellite circuit delay while service observations and circuit rejection counts showed practically no difference between the cable and satellite circuits. (Author)

A67-17667
SUBJECTIVE EVALUATION OF TELEPHONE COMMUNICATIONS VIA EARLY BIRD SATELLITE AND CABLE CIRCUITS.
George K. Helder (Bell Telephone Laboratories, Inc., Murray Hill, N.J.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 85-93.

Results of statistical tests to determine the subjective quality of telephone communications via Early Bird satellite and cable circuits. It was found that quality of cable circuits is significantly better than that of synchronous satellite circuits, that there appears to be no effect on quality rating after repeated use of satellite circuits, and that the quality of satellite circuits with several different combinations of echo suppressors and with tandem echo suppressors is essentially the same. M.F.

A67-17668
EXPERIENCE OF THE DEFENSE COMMUNICATIONS AGENCY IN OPERATING PILOT SATELLITE COMMUNICATIONS.
W. H. Edwards (U.S. Defense Communications Agency, Evaluation and Doctrine Div., Washington, D.C.) and J. S. Smith (System Sciences Corp., Systems Technology Div., Falls Church, Va.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-268.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 97-122. 6 refs.

A67-17669
COMMUNICATIONS VIA SEVERAL SATELLITES USING THE LINCOLN EXPERIMENTAL TERMINAL.
Irwin L. Lebow (Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Mass.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-272.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 123-139. 9 refs.

A67-17670
OPTIMIZATION OF NETWORK CONFIGURATIONS IN A HYBRID SATELLITE AND GROUND COMMUNICATION SYSTEM.
W. Nehl (System Sciences Corp., Computer Applications Group, Falls Church, Va.) and H. Most (System Sciences Corp., Falls Church, Va.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-295.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 141-157.

A67-17672
DECENTRALIZED CONTROL FOR AN ADVANCED COMMUNICATION SATELLITE SYSTEM.
John Bry (Radio Corporation of America, Evaluation and Research Group, Moorestown, N.J.) and Karl Solomon (Radio Corporation of America, Defense Electronic Products, Communications Systems Div., Moorestown, N.J.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 179-191.

Discussion of a decentralized control system for an advanced communication satellite system. Decentralization is achieved by providing each earth station pair with a capability for autonomous reaction to network changes or to deterioration of the network due to equipment failure or interference. The result is a self-sufficient communication facility able to supply minimum emergency service for extended periods in the event of disability of the global control center. The hypothetical model chosen for the communication satellite system is representative of one of several configurations being considered. (Author)

A67-17674
A MULTIPLE-ACCESS WORLD-WIDE SATELLITE COMMUNICATION SYSTEM FOR AIRCRAFT TERMINALS.
Malcolm L. Campbell (Boeing Co., Electronics and Space Science Dept., Seattle, Wash.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-297.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 215-238. 23 refs.

A67-17676
AN ADAPTIVE TWELVE-CHANNEL MULTIPLEXER.
G. D. Hodge, C. A. Kengla, K. M. Roehr (International Business Machines Corp., Advanced Circuit Design Group, Bethesda, Md.), and M. Malinowski (U.S. Army, Satellite Communications Agency, Fort Monmouth, N.J.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-291.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 257-276. 7 refs.

A67-17677
COST EFFECTIVENESS COMPARISON OF DEFENSE COMMUNICATIONS SATELLITE SYSTEMS.
A. Guggenheim, M. H. Garnholz, and H. C. Collins (Hughes Aircraft Co., Advanced Projects Laboratories, Los Angeles, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 277-298. 22 refs.

Study to define military communications missions appropriate for stationary synchronous satellites and to synthesize satellite systems to meet the requirements of these missions. Assessments of general communications needs provide guidelines for system characteristics applicable to a number of predictable satellite communications relay missions. System performance characteristics were defined in cases where a random satellite system consisting of 24 satellites in medium altitude polar orbits had already been postulated to fulfill specified missions. These random system capabilities were then analyzed to establish minimal required characteristics for a synchronous altitude satellite system. The cost effectiveness evaluations showed that: stationary synchronous system effectiveness in a worldwide communications mission is as good as, or better than, that of the specified random system; stationary system costs are less than those of the random system in all cases of satellite and launch reliabilities considered as reasonable, and significantly less in the maximum likelihood case; and the stationary system provides flexibility superior to the random system in meeting additional requirements. (Author)

A67-17678
LAUNCH VEHICLES AS SUPPORT SUBSYSTEMS FOR COMMUNICATIONS SATELLITES.
Barrett Bruch and Charles Wallin (Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Sunnyvale, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-285.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 301-322.

A67-17680
GRAVITY GRADIENT STABILIZATION OF COMMUNICATION SATELLITE SYSTEMS.
R. J. Katucki and R. G. Moyer (General Electric Co., Missile and Space Div., Spacecraft Dept., Philadelphia, Pa.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-303.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 347-374. 7 refs.

A67-17682
A WIDE-BAND SOLID-STATE I.F. REPEATER FOR COMMUNICATIONS SATELLITES.
D. G. Horvath and S. Blum (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-300.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 401-421.

A67-17683
ADVANCES IN TRAVELING-WAVE TUBES FOR SPACECRAFT COMMUNICATIONS SYSTEMS.
M. J. Schindler (Radio Corporation of America, RCA Electronic Components and Devices Div., Harrison, N.J.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-301.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 423-432. 7 refs.

A67-17686
GAIN LIMITS OF ELECTRONICALLY DESPUN ANTENNAS FOR COMMUNICATION SATELLITES.
Stephen N. Andre and Dennis J. Leonard (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Williamsville, N.Y.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-325.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 481-497.

A67-17687
NUCLEAR POWER SYSTEMS FOR ADVANCED HIGH-POWERED COMMUNICATIONS SATELLITES.
J. D. Gylfe (North American Aviation, Inc., Atomics International Div., Canoga Park, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-305.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 501-528.

A67-17689
A DIRECT-TO-HOME TV SATELLITE SYSTEM FOR 1970.
R. B. Marsten and S. Gubin (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-309.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 549-571.

A67-17690 *
SELF-STEERING ARRAYS FOR SATELLITE APPLICATIONS.
W. H. Kummer (Hughes Aircraft Co., Aerospace Group, Antenna Dept., Culver City, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-326.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 573-592.
Contract No. NAS 5-3545.

A67-17692
REQUIRED AND ATTAINABLE INTERFERENCE RATIOS IN SPACE TELECASTING.
R. P. Haviland (General Electric Co., Philadelphia, Pa.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-283.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 619-637. 16 refs.

A67-17693
PARAMETRIC TRADEOFF ANALYSIS FOR COMSAT SYSTEM DESIGN.
Robert J. W. Price (Technical Communications Corp., Lexington, Mass.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-330.)
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New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 641-666. 6 refs.

A67-17694
MULTIPLE-ACCESS MODULATION TECHNIQUES.
D. T. Magill (Philco Corp., WDL Div., Palo Alto, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-278.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 667-680. 6 refs.

A67-17695
A COMMUNICATION SATELLITE SYSTEM FOR MANY USERS.
R. S. Davies and J. M. Stephenson (Philco Corp., WDL Div., Palo Alto, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-279.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 681-694.

A67-17697
TV NETWORK SATELLITE SYSTEMS.
Samuel Gubin and James J. Hawley (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-284.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 713-733.

A67-17698
ESTABLISHMENT AND MAINTENANCE OF A COMMUNICATION SATELLITE SYSTEM.
D. D. Werts (TRW, Inc., TRW Systems Group, Redondo Beach, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-286.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 735-753.

A67-17699
SCHEDULING AND CONTROL OF SATELLITE COMMUNICATIONS SYSTEMS.
Ward Ellis and Morton D. Lenske (Litton Industries, Inc., Mellonics Systems Development Div., Sunnyvale, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-288.)
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Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 755-774.

A67-17701
AERONAUTICAL COMMUNICATION SATELLITES.
John Jansen (TRW, Inc., TRW Systems Group, Space Vehicles Div., Redondo Beach, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 799-818.
Review of new applications of aeronautical communication satellites made possible by the improvement of communications between commercial aircraft on transoceanic routes and ground stations. For the satellite-aircraft links, 118-136 MHz and 1540-1660 MHz are the primary choices from the frequency bands allocated worldwide for this service. The satellite transmitter output power required for a voice communication is approximately 750 watts at uhf or an order of magnitude lower at vhf, if the aircraft antennas use a fixed, single beam for near-hemispherical coverage. It is noted that uhf transmitter power comparable to that at vhf requires a narrow, multi-position aircraft antenna beam or reduced earth coverage. M.M.

A67-17702
POST ECHO II PASSIVE COMMUNICATION SATELLITES AND SYSTEMS.
Charles M. Kelly (Goodyear Aerospace Corp., Astronautics Systems Dept., Akron, Ohio).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-312.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
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New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 819-846. 26 refs.

A67-17704
SOME DESIGN CONSIDERATIONS FOR PLANETARY RELAY COMMUNICATIONS SATELLITES.

Roger D. Bourke (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and Thomas A. Barber (California Institute of Technology, Jet Propulsion Laboratory, Future Studies Group, Pasadena, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-314.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 871-886. 7 refs.

A67-17705
LUNAR COMMUNICATION SATELLITES.
George E. Neuner (TRW, Inc., TRW Systems Group, Redondo Beach, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-315.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 887-908. 27 refs.

A67-17706 *
DEEP-SPACE OPTICAL COMMUNICATIONS.
C. W. Chapoton and J. W. White (Westinghouse Electric Corp., Atomic, Defense and Space Group, Surface Div., Baltimore, Md.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-317.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 909-923.
Contract No. NAS 9-3650.

A67-17707
ORGANIZATION AND PROGRAM OF INTELSAT.
Edwin J. Istvan (Communications Satellite Corp., Washington, D.C.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-332.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 929-939.

A67-17708
BUSINESS FORECASTING FOR COMMUNICATION SATELLITE SYSTEMS.
L. B. Early, L. Kumins (Communications Satellite Corp., Economic Analysis Dept., Washington, D.C.), and J. Baer (Hughes Aircraft Co., Aerospace Group, Space Systems Div., Los Angeles, Calif.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-322.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 941-954.

A67-17711
COMMUNICATIONS IN ORBIT - A LEGAL ANALYSIS AND PROGNOSIS.
Jerome Morenoff (Planning Research Corp., Management Control Systems Div., Washington, D.C.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-277.)
IN: COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY.
Edited by R. B. Marsten.
New York, Academic Press, Inc. (Progress in Astronautics and Aeronautics. Volume 19), 1966, p. 1011-1031. 12 refs.

A67-18050
COMMUNICATION SATELLITES.
G. Mickey Haney and James D. Thompson (Hughes Aircraft Co., Aerospace Group, Space Systems Div., El Segundo, Calif.).
International Science and Technology, Jan. 1967, p. 46-52, 54, 60.

Discussion of experimental and operational communication satellites. The former include Score, Echo 1, and Telstar 1 and 2; communication satellites still operating include Echo 2, Syncom 2 and 3, and Molniya. The next generation of communication satellites is discussed, and satellite telecommunications with automatic routing (STAR) are described. The problem of stabilizing the attitude of the satellite despite the earth's gravitational potential is reviewed, and the use of hydrogen peroxide and, in the future, of hydrogen as fuel for these satellites is discussed. Problems of applied technology are considered. It is pointed out that satellite-to-home TV appears to be only two years away. M.F.

A67-18338 #
DETERMINATION OF THE PACIFIC EQUILIBRIUM POINT FOR A STATIONARY ORBIT.
R. E. Balsam and B. M. Anzel (Hughes Aircraft Co., Aerospace Group, Space Systems Div., El Segundo, Calif.).
American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 5th, New York, N.Y., Jan. 23-26, 1967, Paper 67-91. 10 p. 7 refs.
Members, $0.75; nonmembers, $1.50.

Tracking data obtained from the Syncom 3 satellite over a 7-month period, during which it drifted freely from 188 to 195°W, has been used to derive an accurate estimate of the Pacific equilibrium longitude for a stationary satellite. The analytic techniques used to process the data are described in detail and the results that have been obtained are presented. From sets of orbital elements obtained from the reduction of raw tracking data, mean values of the satellite longitude and drift rate are determined. Thus, the effect on the orbit of the longitude-dependent terms in the earth's potential is isolated from the effect of other perturbing tangential accelerations, primarily those due to the sun and the moon. The mean longitudes and drift rates are then treated as data points and compared with theoretically calculated values of same in a maximum likelihood determination of the equilibrium longitude and the local gradient of the drift acceleration. The theoretical longitude and drift rates are evaluated analytically in terms of elliptic functions. The results of the analyses indicate the best estimate of the equilibrium longitude to be 197.6°W. The importance of accurately locating this point is demonstrated with regard to increasing useful communication life of a Hawaii/Far East link. (Author)

A67-18414
SYSTEM DESIGN OF A PROPOSED DIRECT-TO-HOME TV SATELLITE EXPERIMENT.
R. B. Marsten and S. Gubin (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).
(American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, Washington, D.C., May 2-4, 1966, Paper 66-309.)
IN: SPACECRAFT AND SPACE SYSTEMS.
Camden, N.J., Radio Corporation of America, 1966, p. 12-17. 5 refs.

A67-19762
REPORT OF THE STUDY GROUP OF THE INTERNATIONAL GEODETIC ASSOCIATION ON THE APPLICATION TO EUROPEAN GEODESY OF THE GEODETIC OBSERVATION OF LUMINOUS OBJECTS AT ALTITUDE [RAPPORT DU GROUPE D'ETUDES DE L'ASSOCIATION INTERNATIONALE DE GEODESIE SUR L'APPLICATION A LA GEODESIE EUROPEENNE DE L'OBSERVATION GEODESIQUE D'OBJETS LUMINEUX EN ALTITUDE].
H.-M. Dufour (Ecole Nationale des Sciences Géographiques, Institut Géographique National, Saint-Mandé, Seine, France).
IN: EUROPEAN GEODETIC NETWORK BY SATELLITE OBSERVATION; CENTRE NATIONAL D'ETUDES SPATIALES AND INSTITUT GEOGRAPHIQUE NATIONAL, SYMPOSIUM, PARIS, FRANCE, DECEMBER 14-16, 1964, REPORTS [RESEAU GEODESIQUE EUROPEEN PAR OBSERVATION DE SATELLITES; CENTRE NATIONAL D'ETUDES SPATIALES AND INSTITUT GEOGRAPHIQUE NATIONAL, SYMPOSIUM, PARIS, FRANCE, DECEMBER 14-16, 1964, COMPTES RENDUS]. [A67-19756 07-13]
Paris, Institut Géographique National, 1965, p. 85-87; Discussion, p. 87, 88. In French.

Study of conditions for the application to European conditions of geodetic observations of luminous objects in the sky, the goal being to define, on the scale of Europe, those geodetic operations which can be considered "profitable," to identify European cooperation with the establishment of a world network, and to determine the instruments and methods to recommend for these two operations. An Echo-type satellite will be used at an altitude between 1000 and 1500 km. F.R.L.

A67-19765
ACCURACIES ATTAINED ON THE FIRST 900 MILE TRIANGLE IN THE COAST AND GEODETIC SURVEY'S SATELLITE TRIANGULATION PROGRAM.
James K. Richards (ESSA, U.S. Coast and Geodetic Survey, Washington, D.C.).
(American Congress on Surveying and Mapping, 1964 Regional Convention, Kansas City, Mo., Sept. 24-26, 1964, Paper.)
IN: EUROPEAN GEODETIC NETWORK BY SATELLITE OBSERVATION; CENTRE NATIONAL D'ETUDES SPATIALES AND INSTITUT GEOGRAPHIQUE NATIONAL, SYMPOSIUM, PARIS, FRANCE, DECEMBER 14-16, 1964, REPORTS [RESEAU GEODESIQUE EUROPEEN PAR OBSERVATION DE SATELLITES; CENTRE NATIONAL D'ETUDES SPATIALES AND INSTITUT GEOGRAPHIQUE NATIONAL, SYMPOSIUM, PARIS, FRANCE, DECEMBER 14-16, 1964, COMPTES RENDUS]. [A67-19756 07-13]
Paris, Institut Géographique National, 1965, p. 106-117. 5 refs.

This paper discusses the preliminary results obtained from the Maryland-Minnesota-Mississippi Echo 1 satellite-observation triangle. The test adjustments of the satellite triangulation employed six events: two three-station simultaneous observations and four two-station observations. Preliminary results indicate that the internal consistency of the spatial triangulation is very favorable. The principles of the satellite triangulation method, the camera systems, and the office data-reduction techniques are discussed briefly. Some of the future plans in the Coast and Geodetic Survey's satellite-triangulation program are also covered. (Author)

A67-19767
THE GEODETIC LINKING OF FRANCE AND NORTH AFRICA BY SYNCHRONOUS PHOTOGRAPHS OF THE ECHO 1 SATELLITE [LA JONCTION GEODESIQUE FRANCE-AFRIQUE DU NORD PAR PHOTOGRAPHIES SYNCHRONES DU SATELLITE ECHO I].
H. M. Dufour (Ecole Nationale des Sciences Géographiques, Institut Géographique National, Saint-Mandé, Seine, France).
IN: EUROPEAN GEODETIC NETWORK BY SATELLITE OBSERVATION; CENTRE NATIONAL D'ETUDES SPATIALES AND INSTITUT GEOGRAPHIQUE NATIONAL, SYMPOSIUM, PARIS, FRANCE, DECEMBER 14-16, 1964, REPORTS [RESEAU GEODESIQUE EUROPEEN PAR OBSERVATION DE SATELLITES; CENTRE NATIONAL D'ETUDES SPATIALES AND INSTITUT GEOGRAPHIQUE NATIONAL, SYMPOSIUM, PARIS, FRANCE, DECEMBER 14-16, 1964, COMPTES RENDUS]. [A67-19756 07-13]
Paris, Institut Géographique National, 1965, p. 131-140. In French.

Review of the general principles of triangulation by satellite, with a description of the equipment used. The general characteristics of the ground operations for the France/North Africa link are indicated, with reference to preparations for observations, ground work, and practical results. The work of interpreting the plates and the computing program are briefly reviewed. F.R.L.

A67-19769
PRELIMINARY RESULTS OF PROCESSING OF SYNCHRONOUS PHOTOGRAPHIC OBSERVATIONS OF THE SATELLITE "ECHO I."
I. A. Kutuzov (Akademiia Nauk SSSR, Moscow, USSR).
IN: EUROPEAN GEODETIC NETWORK BY SATELLITE OBSERVATION; CENTRE NATIONAL D'ETUDES SPATIALES AND INSTITUT GEOGRAPHIQUE NATIONAL, SYMPOSIUM, PARIS, FRANCE, DECEMBER 14-16, 1964, REPORTS [RESEAU GEODESIQUE EUROPEEN PAR OBSERVATION DE SATELLITES; CENTRE NATIONAL D'ETUDES SPATIALES AND INSTITUT GEOGRAPHIQUE NATIONAL, SYMPOSIUM, PARIS, FRANCE, DECEMBER 14-16, 1964, COMPTES RENDUS]. [A67-19756 07-13]
Paris, Institut Géographique National, 1965, p. 153-156; Discussion, p. 156, 157.

Description of results and conclusions obtained from two periods of observations of the satellite Echo 1. The results of astrometric processing of observational materials and of the preliminary computation of space triangulations are given. M.M.

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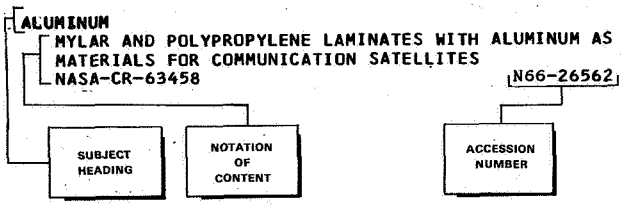

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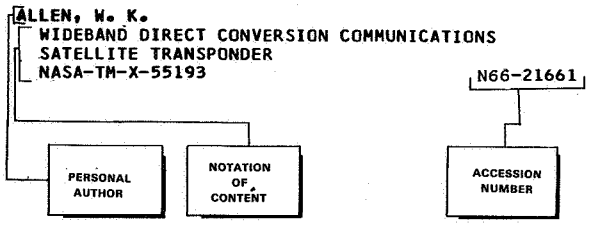

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